THE AMERICAN GAS LIGHT JOURNAL

REDMANHENRY.N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXVIII.—No. 3. Whole No. 1,180. | NEW YORK, MONDAY, JANUARY 17, 1898 | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager. THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

Published on each Monday of the year, at No. 32 Pine Street, New York.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

CONTENTS

An Asterisk (*) denotes an illustrated article.

OFFICIAL NOTICE—
Fifth Annual Meeting, Michigan Gas Association 81
EDITORIALS—
Briefly Told 81
Notes.
Illinois Coke 82
*Indirect or Diffused Illumination of Class Rooms and Workshops by Welsbach Incandescent Lamps 82
Gas Manufacture and Appliances—Meters 83
The Management of Central Station Meter Systems 85
Extensions to the Plant of the Niagara Falls Power Company 87
Changes in the Patent Laws 88
*On the Solubility of Ammonia in Water at Temperatures Below 0° C., by Mr. J. W. Mallett 88
On the Densities of Carbonic Oxide, Carbonic Anhydride and Nitrous Oxide, by Lord Rayleigh 90
The Relation of the Mining Engineer to the Economic Operation of Coal Mines, by Mr. S. A. Taylor 91
On the Densities of Nitrogen, Oxygen and Argon, and on the Composition of Atmospheric Air, by A. Leduc 92
ITEMS OF INTEREST FROM VARIOUS LOCALITIES 93
The Projectors of the Opposition Company, Leavenworth, Kas.—A Liberal Subscription—Cheaper Gas for the Suburban Districts of Newark, N. J.—A Correction—Annual Meeting, Consumers Company, Woodbury, N. J.—Public Lighting, Minneapolis, Minn.—Consolidation, Middletown, Ohio—Mr. Butterworth Discusses the Question of Repairs to Meters by Gas Companies—Swedish Comments on Impure Gas at Mount Vernon, N. Y.—The Detroit Meter Company—Advances Gained, Ashtabula, O.—Mr. Aiken Resigns—Proposed Opposition for Sioux Falls, So. Dak.—Annual Meeting, Girardville, Pa.—Annual Meeting, New Haven, Conn.—Talking Consolidation, Lorain, Ohio—Hints from Richmond, Va.—Death of Mr. Gilbert Darling—Natural Gas and the Canadian Government—Public Lighting, Dover, N. H.—And Other Items.
An Isolated Plant Driven by Gas Engines 95
The Market for Gas Securities 95

[OFFICIAL NOTICE.]

Fifth Annual Meeting, Michigan Gas Association.

OFFICE OF THE SECRETARY,
SAGINAW, E. S., MICH., Jan. 11, 1898.

To the Members of the Michigan Gas Association: Gentlemen—You are hereby reminded that the fifth annual meeting of our Association will be held on Wednesday, the 16th, and Thursday, the 17th, days of February next, at Port Huron, Mich.

The new Hotel Harrington has been selected as Association headquarters, with rates, for all rooms without bath, at $2.50 per day; with bath, at $3 per day. From experience at our recent meetings it would be well to have rooms reserved as early as possible.

The following papers will be presented for consideration:

"Experiments with the Welsbach Lamp," by Mr. Frank H. Hess.
"An Automatic Closed Purifier," by Mr. Henry G. Beatley.
"Our Patrons: How to Treat Them," by Mr. S. Milo Dole.
"The Utilization of Coal Tar by Distillation," by Mr. Edward J. Ellis.
"Reminiscences," by Mr. Robert Calhoun.

Mr. Fred. J. Howden will also present a paper, the title of which is not received. Respectfully yours, HENRY H. HYDE, Secretary.

BRIEFLY TOLD.

NOTES.—We understand that those in authority in the Western Gas Association have determined to name Detroit, instead of Mount Clemens, as the place for holding the next meeting of the Association. This action, of course, is preliminary, for the substitution must be approved by the Board of Directors before a finality is reached. The reasons or causes leading to the change of base are unknown to us, but evidently they must have been weighty to cause such a revolutionary procedure.——The syndicate headed by Mr. H. A. Odell has secured control in the Dedham and Hyde Park (Mass.) Gas and Electric Light Company. The purchasers have perfected the following rearrangement of the Company's executive management: President, H. A. Odell; Treasurer, S. R. Bertron; General Manager, Walter P. Elliot. The likelihood is that Mr. J. R. Todd will be continued as Superintendent. ——Mr. Fred. L. Barnett, the sensible Superintendent of the city lighting system of Des Moines, Iowa, recently was deputed by the authorities of that place to investigate the relative merits of the lighting of the streets of other cities—he visited, during his trip, St. Louis, Detroit, Buffalo and Chicago—as compared with the lighting in Des Moines. The net result of his examination is that Des Moines is better lighted than any one of the comparative places, save Buffalo; rates paid and service rendered being taken into account in the estimate.——At the annual meeting of the Hartford City (Conn.) Gas Light Company the Directors chosen were: Hugh Harbison, F. B. Cooley, Jas. L. Howard, Henry K. Morgan, George Roberts, Atwood Collins, Jno. P. Harbison, Nathaniel Shipman and H. A. Redfield. The annual reports show that the General and his confreres are still pretty well to the fore in the business of supplying artificial light from a central station in Connecticut's handsomest city.——The officers chosen by the Directors of the Peoples Gas Light and Coke Company, of Chicago, Ills., for the ensuing year, were: President, C. K. G. Billings; First Vice-President, A. N. Brady; Second Vice-President, Walton Ferguson; Third Vice-President, C. W. Wooster; Secretary and Treasurer, L. A. Wiley; Assistant Secretary, H. W. Olcott; Assistant Treasurer, J. S. Zimmerman; Second Assistant Secretary and Treasurer, F. A. Crane. In connection with the stockholders' meeting (the Directors are Messrs. Roswell P. Flower, A. N. Brady, Walton Ferguson, F. S. Winston and C. K. G. Billings) the following further action was taken, on the advice of the controlling interest: "The consolidation with the Peoples Gas Light and Coke Company last August of seven other gas companies has made it impossible for the Auditor and Treasurer to prepare the annual report for the year ending December 31, 1897, in time to be submitted at this meeting of the stockholders. Before an accurate and

complete report can be made up, it is necessary to ascertain the amount of gas sold to consumers in the month of December, and to adjust with the city officials the amount due to the city of Chicago, which is 3½ per cent. of the gross receipts of the Company for the year. You will be requested, therefore, when you adjourn, to adjourn for a sufficient length of time to enable a full report to be prepared and submitted to such adjourned meeting." In accordance with that suggestion or direction, the stockholders' meeting was adjourned to February 10th.——Secretary Aldrich, of the Spokane Falls (Wash.) Gas Light Company, has been authorized to promulgate the following rate schedule on illuminating account, which is to rule until further notice: 100 to 900 cubic feet, $2.50 per 1,000 cubic feet, less 10 per cent. for prompt payment—within 10 days; 1,000 to 3,000 cubic feet, $2.50 per 1,000, less 20 per cent.; 3,000 cubic feet and over, $2 per 1,000, less 20 per cent. On fuel supply account the rates are: 100 to 900 cubic feet, $2.50 per 1,000, less 20 per cent.; 1,000 to 3,000, $2.50, less 30 per cent.; 3,000 cubic feet and over, $2, less 25 per cent.——The Kansas City, Missouri, Gas Company, through its Secretary, Mr. R. McMillan, on the 8th inst., paid into the Treasury of Kansas City the sum of $6,547.17, which represented 2 per cent. on the receipts for gas by the Company for the six months ended December 31, 1897.——The consolidation of the gas and electric interests of Carthage, Mo., has been completed. The name of the succeeding corporation is the Carthage Light Company, and its Secretary is Mr. George M. Myers.

Illinois Coke.

The *Iron Age* says that from present appearances the next great development in the iron trade will be the production of coke of good quality from Illinois coal. The iron and steel manufacturers at the head of Lake Michigan enjoy a location which gives them peculiar advantages in many ways. They have cheap ores, the lake vessels unloading their cargoes in the blast furnace yards. They have a very large territory over which their product can be cheaply distributed, both by rail and water transportation. To the eastward their nearest competitors are located in Ohio, 250 to 300 miles distant. To the westward, Colorado is the nearest State in which raw materials are assembled and converted into finished products. But up to the present time the Lake Michigan producers have been obliged to draw their supplies of coke from the same district supplying the producers of Western Pennsylvania, West Virginia and Ohio. Thus the advantages of their location have been to a considerable extent offset by the high cost of fuel caused by the long rail haul of at least 525 miles. They can put in the most approved appliances for handling material and can adopt the most approved methods for saving labor and economizing fuel, but in these respects they can perhaps do no better than their Eastern competitors, who are also thoroughly progressive, and therefore they can gain no advantage so long as they are handicapped by dear fuel. The coke problem is consequently not only an inviting proposition because of the great element of cost which is open to attack, but that attack seems to be a pressing necessity in these days of sharp competition.

The way to solve the problem is unquestionably by means of the utilization of native coal as a blast furnace fuel. Illinois coal has been coked for years on a limited scale and in desultory fashion, but the coke thus produced has not been satisfactory either for blast furnace or foundry use. The beehive oven was not suited to it, and while coke of fair quality was sometimes turned out, it was more frequently either too friable or too sulphurous for the market. The retort or bye-product ovens, however, have been tested with excellent results.

Illinois coal from various sections of the State deposits has been found to yield a coke of good structure and satisfactory quality, and the time is near at hand when the Illinois iron trade will draw their coke supply from local sources. While the Illinois Steel Company have not yet formally announced their intention to erect ovens to make their own coke, intimations are not wanting that this is soon to be done. Meanwhile others are working in the same direction, and it will not be surprising to see more than one enterprise of this character under way in the vicinity of Chicago before the year begins to wane.

The effect upon the iron trade will not be merely local. If coke of good quality, fit for blast furnace use, can be delivered at the stack for $2 per ton, as is claimed by the more sanguine, it means not only an impregnable position for the Lake Michigan iron producers in their own territory, but a wider zone for outside operations. Every dollar of reduced cost of production at Chicago means an extension of the market from 100 to 150 miles further east or south. It also means the continued upbuilding of industries in the vicinity of Chicago and its greater prominence in the future.

[Translated for the JOURNAL by Mr. Herman Poole, F.C.S.]

Indirect or Diffused Illumination of Class Rooms and Workshops by Welsbach Incandescent Lamps.

By DR. F. KERMANDER and PROF. W. PRAUSNITZ, in the *Journal des Usines a Gaz.*

The value of the artificial illumination of a room depends on the nature of the illuminating bodies, their number and installation, or distribution. As for the latter point, only very few data have been published so far, and this lack has been made more apparent by the studies of the authors in this direction. Artificial illumination of class rooms, halls and shops requires different types. We may distinguish the principal methods of distribution as follows:

1. Central illumination, by one or more chandeliers.
2. Side illumination by single jets.
3. Illumination by a greater or less number of single jets distributed in the room.

In the first two types, the illumination of a room is generally very irregular. We may relieve this irregularity somewhat by placing a large number of lights in the room. On the subject of illumination by a large or small number of separately distributed jets in a room, facts are very rare as to what relates to the necessary number for clear vision, and at the same time a sufficient protection for the view. Where the lighting is disseminated, so as to have one jet per person, we may easily obtain the requisite amount of light and may completely remedy the fatigue of the eyes by properly placed shades. But the installation and working of a light system of this kind causes, independently of other inconveniences, such an excessive production of heat and alteration of the air, disadvantages necessitating an expense for relief too great to allow general application in shops, schools, auditoriums, etc.

For a long time we have been obliged to satisfy the conditions of good artificial illumination in other ways. Still, these efforts have been crowned with success only in the last few years by the introduction of indirect or diffused illumination. In halls, and in rooms used for the assembling of a large number of persons, this method of lighting permits at each portion a sufficient brightness without confused illumination at any point; furthermore, the assistants are effectually protected from the effects of the heat rays emanating from the lights.

This indirect illumination consists, in principle, of preventing the light emitted by the luminous bodies from arriving directly at the different places; the light is, on the contrary, totally or partially projected by reflectors to the ceiling or the walls, from which it diverges uniformly in all directions. The whole room illuminated by this method produces a special impression, and one which is a little confusing, at first. But we soon appreciate the beneficent action produced on the sight by this method; for we are not troubled at all with flames, bright or naked, nor by the radiating heat, yet we see very distinctly all over the room.

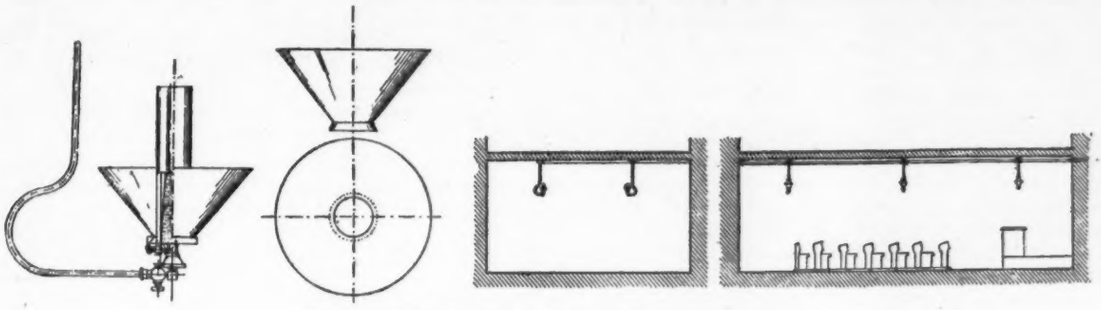
The authors cited made a very complete and perfectly observed series of experiments, and they established the foundations of indirect illumination by the Welsbach light. These facts, apply, moreover, to the illumination of all rooms having ceiling and walls of a light color, and in which is placed one burner for every 120 square feet. It is well understood that the distribution of the sources of light should be absolutely uniform. The intervals between the lamps and the walls should be nearly one-half the interval between the lamps themselves.

The installation of Welsbach burners is shown in Figures 1 to 4. Figs. 1 to 2 show the application of a little ring of brass to the lower portion of the burner, on which rests an inverted shade of opal glass which almost conceals the mantle from view.

The diameter of this shade is 2.4 inches at the lower opening, and 9.8 inches at the upper one; the slant height is 4.5 inches. The lamps are suspended, preferably at the distance of about 3 feet from the ceiling and 6 feet from the tables of the room.

The quantity of light in different portions of the room in which we may thus easily do needlework varies from 28.6 to 37.7 candle feet. It averages, then, the minimum illumination of 32.8 candle feet determined by Prof. Cohn.

We may form an idea of this brightness by horizontally advancing a sheet of paper towards a stearine candle; the portion of the paper about 6 inches below the flame, and at a lateral distance of 8 inches, is illuminated with a brightness equal to one placed at a lateral distance of 3 feet from a source of light of 10 candles. The brightness of 32.8 candle feet is certainly no greater, but it is sufficient for reading, writing, etc.



Indirect Illumination with Incandescent Burners.

The most important results of these experiments may be summed up as follows :

1. Indirect or diffused illumination is the best for class rooms, as well as for halls or shops which do not carry on very fine work.

2. For the illumination of places in which a uniform light is required it is preferable to use Welsbach burners, with the light distributed by conical shades of opal glass placed with the greater opening upward.

3. In rooms mentioned in No. 1 above, that illumination which will send to every part a quantity of light equal to 28 to 33 candle feet may be considered perfect and capable of answering all requirements.

4. This illumination, under the conditions indicated, may be realized by using a Welsbach burner for each 120 square feet of floor surface in rooms about 13 feet high.

5. This method presents, besides the general advantages, the particular advantage that the expense of installation and maintenance are not only absolutely, but relatively, very low.

Gas Manufacture and Appliances.

In the XXXV. chapter (which is the concluding one) of the series of articles on "Gas Manufacture and Appliances," that have been serially contributed by Mr. Henry O'Connor to the *Gas World*, the author has this to say on the matter of meters :

Unfortunately, for many reasons, the gas manager's control of the supply of gas ends at the meters. When the public can be educated into understanding that it is to the gas company's benefit that their consumers shall be satisfied and that they have no advantage through the careless use of the commodity they are supplying, then will one of the many troubles of the gas manager be removed. This cannot be done by circulars, nor is it helped by the burner hawker, who naturally extols his wares to the detriment of all others ; but why more is not done in the way of lectures, either by the gas engineer himself or by others, if he may not have the time or inclination, upon "The use and abuse of gas," with illustrations of different burners and governors, is not clear. Such lectures, given in the same way as the now familiar cookery lectures delivered at every exhibition of stoves, would educate the people, and would, no doubt, bring them to regard the use of good burners and fittings as an essential part of thorough home management. At the same time the descriptions of the different kinds of meters, with illustrations and models of their parts, would bring that box of mystery clearly to their understanding.

What is Required of a Meter.—As has been mentioned before, the wet meter is of much the same construction, whether it be a large station meter or for only a few lights in a consumer's house. But whereas the one is under the gas manager eye at all times, the other is only seen occasionally ; therefore means for the prevention of fraud have to be adopted. These means must be such as will obviate the possibility of fraud, either on the part of the consumer or on that of the supplier, and hence the passing of the Sales of Gas Act. This Act states in what manner the meter shall be tested, and also how it shall receive the seal of the inspector should he find it conforming to the regulations laid down. One of the regulations is that it shall not be capable of passing gas and registering when it is more than 2 per cent. fast—that is, when it is in favor of the supplier—or 3 per cent. slow, in the consumer's favor. The methods adopted for preventing these excessive variations are simple and effective. The gas, as it enters the meter, has to pass through a box with a hole in it, into which fits a conical valve. This valve is connected to a float, which, of course, rises and falls with the level of the water in the meter, so that, should the water get low, the float and valve fall, and the latter closes the passage way for the gas, and thus prevents the gas passing until more water is put in. In this way the capacity of the meter is prevented from becoming greater than is allowed by the Act, the float being set at such a height that the valve will be closed when the level of the water makes the drum 3 per cent. larger than its normal or net capacity. As regards the other side of the range—namely, the 2 per cent. fast—this is ensured by the fitting in of a water line tube which is cut so that when the water is filled in up to a certain height any further quantity runs over the tube and into a water box below, whence it runs off through a sealed tube. When, therefore, a wet meter is to be filled with water, the plug on the top is removed and water poured in through a funnel until it is seen issuing from the hole near the bottom of the front plate. This is usually filled up with a brass plug which must be removed. For the easier setting of the height of the overflow a tube of block tin with a twist in it and a screw working into the head of the tube has been adopted. By turning this screw the tube is raised or lowered, and the whistle-shaped opening in the side of it is brought to the level at which it is desired to run off the water. This saves the trouble and time of opening the meter and cutting or adding to the overflow tube, as it can be easily worked from the outside. For the prevention of fraud this screw head has to be embedded in sealing wax, and is stamped by the inspector.

Putting the Meter Together.—The case of a wet meter, of cast iron, is made in three pieces, the case or pot, the front, and the name plate. The first is a shallow cylindrical vessel with a bottom, and with a narrow flange on the upper edge turned inwards ; this is to contain the drum. This is drilled through the center and a hard metal bush fitted in to carry the spindle ; then a hole is bored at the top, and this is screwed to fit the outlet coupling which will afterwards be fixed there. This part has a back plate to cover over the open end of the case and has to have a number of holes drilled in it, for the inlet coupling, the water filling tube, the screw (if the movable overflow is to be used), and the hole into the waste water box at bottom, also a hole for the entrance tube and a small one for the front bush. Besides these special holes there are other small ones to be drilled through for the connecting of the front of the case ; this is done by small screws which fit into the tapped holes in the case. The holes in front and case are drilled together so as to insure their agreeing ; and to save marking and center punching countersinks are made in the patterns where holes are to be bored, so that the drill enters there without trouble. The nameplate is also drilled in the same way with the front. When all the castings have been drilled and tapped where required, they are handed over to the fitter, who commences to put in the various parts, as the drum, the spout, which is fastened usually with a jam nut to the shelf, the float and valve box, also fastened to the top with a jam nut, the overflow tube, and the upright spindle tube. This tube comes down around the spindle and seals itself in the water, so that no gas escapes where the spindle leaves the case, and no stuffing box is required. The upright spindle has a toothed wheel at the lower end, and this gears into a worm upon the spindle of the drum, so that motion is given to the upright spindle by the revolution of the drum ; this motion being afterwards used to drive the index by means of a second worm on the upper end of the upright spindle.

Testing and Proving.—Having fitted in all these parts, the castings are screwed together and the meter is ready for the proving. It is then filled with water until the overflow indicates that sufficient has been put in, and is usually left for 24 hours to stand, to see if any leaks show themselves. The meter is next placed upon a level bench, and gas connected to its inlet tube and the outlet connected to a float of lights. Gas, at 3 inches pressure, is passed through the meter until all air is expelled and the lights on the float are burning clearly, when

the burners are all extinguished, with the exception of certain ones, which will, together, allow the passage of one-twentieth of the total capacity of the meter, or not less than half a cubic foot per hour as a minimum. Then a small jet is applied all around the meter, and especially at the joints, to see if any gas is escaping, thus proving if the meter be sound. Now we must find if the meter is capable of passing its alleged quantity. This is done by passing air through it from a holder, and noting the time taken to pass a certain quantity of air; this must be done at ½-inch pressure. The holders used are most carefully graduated, and show hundredths of a cubic foot; but an experienced operator can detect differences of thousandths of a foot where necessary. The bell of the holder has to be counterbalanced in such a way that the immersion of the metal of which it is formed has no effect upon the weight of it, and consequently upon the pressure thrown by it. Without this counterbalancing a holder would, perhaps, show a press ure of 8 tenths when fully up, and only some 3-tenths when submerged, and thus would not suit where such accurate testing is required. For the correction there is used either a helix, with a weight pendant from it, which brings the weight nearer the center of the wheel over which the balance chain passes, and thus reduces the counterbalancing effect, the lower the holder passes into the water; or a chain with heavy links may be employed, the weight of the links on the holder side of the balance serving to weight the holder proportionately. More recently a system of siphons has been adopted, by which water is passed from the tank into a central chamber on the bell as the latter falls into the water, thus increasing its weight as required.

Returning to the testing of the meter, having found that it is capable of passing the requisite quantity, a brass dial is fixed upon the upright spindle, which dial is divided into 100 parts for more exact reading. Air is passed through the meter from the test holder, but upon the outlet coupling is fitted a cap with a hole in it which will just allow the correct quantity of gas to pass through for which the meter is designed. The air is passed from the holder through the meter, and by means of the dial an exact reading can be obtained, so that the percentage of difference between the meter registration and the amount of air passed can be accurately gauged. If the meter be correctly set the amount indicated on the holder will be $\frac{3}{100}$ less than that shown by the dial on the meter, as it has been filled fully with water. But a test has also to be made of the quantity which can be passed at the low water line, and to do this water has to be siphoned off from the filling tube until the valve is closed. This can be quickly seen if it is noticed when the revolution of the drum ceases, then a small quantity of water is returned to the meter until it will pass the correct quantity of gas or air per hour for which the meter is made. The holder is connected and a test made and the difference again noted, which should then be 3 per cent.; that is, the holder should show $1\frac{3}{100}$ of a foot, while the dial shows 1 foot exactly. Frequently the dial is dispensed with, and the revolutions of the drum itself noted. As the capacity per revolution is known it is easy to check the exact size of it. The drum is marked with two black paint marks a short distance apart, so that as it revolves under the outlet hole the first mark acts as a caution and the second shows the exact point to be stopped at. In the case of a 2 light meter twelve turns of the drum equal 1 cubic foot, while with a 3-light eight turns gives the same amount, so that these numbers of turns are usually taken; and any error in the capacity accumulates, which shows them very clearly.

The following table gives the usual capacity of one revolution of the drum and also the number of feet per revolution of the upright spindle.

2-light	wet meter	0.083	ft.	per	rev.	drum	2½	ft. per rev.	upright spindle.
3	"	0.125	"	"	"	2	"	"	"
5	"	0.25	"	"	"	4	"	"	"
10	"	0.5	"	"	"	8	"	"	"
20	"	1.0	"	"	"	20	"	"	"
30	"	1.5	"	"	"	20	"	"	"
50	"	2.5	"	"	"	25	"	"	"
60	"	.3	"	"	"	40	"	"	"
80	"	.4	"	"	"	40	"	"	"
100	"	.5	"	"	"	50	"	"	"

Compensating Arrangements.—In the manufacture of the drums and the design adopted the amount of spitooning largely influences the capacity, and also the quantity of water which can be withdrawn from the meter between the high and low water line. The last is a very important item, as that one will require more frequent watering which only permits of a small quantity of water being withdrawn. In the early days of wet meters a very mistaken idea was in vogue that the quantity must be made large at any cost, and the cases were therefore made larger just at the water line; but as this also allowed a larger surface of water to be exposed to the gas, the evaporation was correspondingly quicker. One of the first suggestions was to make the drum of little or no depth at the center, but broader in proportion at the rim. This answered the purpose, but required a larger case and larger drum. Other plans have been to introduce spoons, which lift water from an overflow box at each revolution of the upright spindle and put it into the meter. Another plan was to put a float in the water, which descended and took the place of the water evaporated, so that the level of the latter was constant, and, of course, the registration of the meter likewise constant. A further method was to place a small drum inside the larger, and, as the water fell, to allow a certain quantity of the gas contained in each chamber to pass back to assist in filling the next, instead of allowing it to pass out to the case in the usual manner. A similar effect is also gained by means of a series of boat-shaped boxes in each compartment, which also remove such quantity of gas from the compartment as will compensate for the increased capacity due to the level of the water. Into the hundred-and one little modifications of meter parts it is impossible to enter, but sufficient has been said to enable the student to understand the design of the various compensating arrangements.

The Dry and Prepayment Meters.—The dry meter consists of a pair of circular bellows, into which the gas is led alternately by means of slide valves somewhat similar to those working the ports of an engine. These bellows are made by tying on to a tin rim or band a strip of leather—Persian sheepskin. This tying on is done in different ways by different makers, some using several turns of string, others a flat band of steel with screws to tighten up; but perhaps the best plan is to use a thin soft tinned iron wire, as then the ends can be soldered to the rim and made absolutely secure. The wire is kept at an even tension throughout the tying, and the leathers are afterwards thoroughly oiled with fish oils. When the bellows are fitted in they are tested with gas, to see if there is any leak, before the case is closed up. The slide valves are made of a hard white metal, which does not corrode, and are ground to a very smooth face; the emptying and filling of the bellows causing the revolution of a shaft which works not only the covers of the valves, but also the index itself. Any grit upon the surface of the valves causes leakage and uneven and jumping lights. Then the meter is tested for soundness and capacity; and to fix the latter, the tangent, to which the arms, worked by the bellows, are attached, is made with a slot so that the amount of opening of the bellows is regulated according to the position of the pin in the tangent. When this has been fixed the top is soldered on, and the meter is ready for the official inspector.

The prepayment meter has taken so many different forms that only a general decription can be given. The main features of all are that on the insertion of a penny a valve is opened which allows the gas to pass through, and when the quantity for which the meter is set has passed, the valve gradually closes, this gradual closing serving as a warning that the amount paid for is nearly consumed. The great points to be noted in such meters are that the valve shuts off absolutely tight; that the money in the box will agree exactly with the amount indicated by the ordinary index; that no means of obtaining gas are possible other than by the use of coins of the right dimensions; that the money cannot be withdrawn without opening the box; that one piece of money cannot be made to do duty several times over, either by means of soap, pitch or birdlime on the side of it, so that it may stay in the mechanism and work round several times, or that a piece of string may be attached to the coin and the same withdrawn after use. All these are overcome in the best of the prepayment meters. Although the writer can obtain gas from several of them without the use of coins at all, it is possible that even these in the hands of the general public may prove fairly safe. One addition is almost a necessity in all prepayment meters, and that is a stop action which will close up the slot where the pennies are inserted when the dial has shown that the full amount for which the meter is made has been prepaid. As regards the indication of the amount of gas paid for but unconsumed, this is not of much moment. It is almost impossible to arrange such mechanism without some shake, and this must be taken up before the wheels will revolve, so that should the dial show less than the full amount expected, it does not indicate that the meter is likely to pass less than the correct quantity; but it may be noticed that before the dial moves there will be sufficient gas passed to make up for the lesser quantity pre-indicated.

THE new gas inspector for Louisville, Ky. (Mr. Henry Hoertz) has decreed that hereafter the table for lighting the public gas lamps in the City Hall be maintained strictly on the basis of 4,000 hours for each light per annum.

The Management of Central Station Meter Systems.

By Caryl D. Haskins, in *Electrical World.*

Much has been written regarding the selection of a desirable meter. Central station managements, which a comparatively brief time ago based their selection of a meter first upon the initial cost and second upon the accuracy of the meter under average loads, have come to a realization of the importance of looking for many other merits and demerits. If they are operating an alternating current plant they realize that they must secure accuracy upon inductive loads, upon different wave shapes and upon different frequencies; and whether the system be direct or alternating in character, they realize that light load accuracy is of the most vital importance.

The details of care and management of the meter system necessary to secure the best results have received careful attention of a systematic kind in isolated cases only, for it would seem to be a common belief that the mere fact of purchase of satisfactory meters is regarded as sufficient to insure good operation over long periods.

As a matter of fact, the influence of proper meter care and intelligent managent have a most important influence upon revenue, and this care should begin with a wise selection of the meter which is to be installed upon each individual customer's circuit, particularly as regards the size of the meter to be used. A very large proportion of a central station's output goes to supply loads of one or two lamps, and unless diligent care is used quite a large percentage of such loads fails to be properly recorded upon the meter, and the central station's revenue suffers accordingly.

This consideration is of special importance in connection with domestic lighting, which is not infrequently regarded as unprofitable. That lighting of this character can be made profitable in almost every case by careful attention to the question of metering is certain.

Generally speaking, needlessly large meters are installed on the average system. In all meters the light loads are the critical points of accuracy curve, and for this reason meters should always be installed in as small units as possible.

It is better to err on the side of too small meters than upon the side of too large meters. It is better to lose an occasional meter from a burnout resulting from extreme overload, than to lose a considerable percentage of the revenue which should be secured from long sustained light loads.

This is a point which should not be lost sight of in the selection of a meter. Not only is ability to sustain heavy overloads for considerable periods of very great importance, but accuracy on overloads is quite vital.

All forms of meter have a range of speed through which they perform their functions to the best advantage, both accuracy and life being considerations in determining this speed. If the load upon the meter fall so low as to bring the speed of the meter below the minimum of this speed range, then accuracy suffers. On overloads the speed of the meter is carried up above the maximum of the normal range, and with a properly selected meter accuracy should not be impaired. The life of the meter may suffer, and of course upon extremely heavy overloads the insulation and structure of the meter will suffer by reason of the mere development of heat. Overloads may, therefore, if carried to extremes, mean meter repairs; that is, a small expenditure. Extremely light loads mean direct loss of revenue, and practice teaches us that these light loads should be avoided, even though such avoidance means an occasional overhauling. The increase of just revenue due to a systematic following of this practice will be found to cancel many times over the relatively small expenditure incident to damage resulting from overload, even though occasionally, as now and then occurs in domestic lighting, someone gives an unexpected party, resulting in a burnt-out meter and the necessary installation of a new instrument.

In large buildings the conditions are frequently such as to render it peculiarly difficult to meter to good advantage. An excellent example of this class is to be found in the average theater or church installation, where a very large number of lamps are used for long periods very frequently. Yet in this very class of installations relatively very small loads are constantly used for many hours at a time. It is almost impossible to install a meter large enough to care, even on a heavy overload basis, for the entire installation which is so frequently used, and yet secure any reasonable accuracy on the long sustained light loads.

These are very radical cases, and it will be found vastly more profitable to meet them with radical measures than to install a large meter and lose a considerable percentage of the revenue due to the central station company for light load service.

In all cases of this kind it is cheaper in the end to split the service and run two, three or four separate circuits, each with its individual meter. In a theater, for example, 1, 2, 3 or 4 lights, indeed as high as 20 lights in some cases, burn for the greater part of the time in the offices, entrance and main corridor, while during the performance the lights run up to 600 or 800. First-class accuracy should not be expected from a meter fit to withstand commercial use for any length of time on loads of less than 5 per cent. of its rating. In a case of such a 500 or 600-light theater, therefore, a single meter would lose to the central station a very large percentage of the revenue properly due for light furnished in the offices and in the entrance.

The remedy is to place the offices and corridors upon a separate circuit having a separate meter, and in very large theaters it is frequently profitable to make the offices, the corridor and entrance, the house and the stage all independent.

This same line of practice should be followed, not alone with theaters, but with all of that large class of installations using both very heavy and very light loads for long sustained periods.

It is commonly understood that light load accuracy is a critical point with all meters, but it is not so commonly understood that this light load accuracy, or rather inaccuracy, is largely dependent, first, upon the installation and, second, upon the care which is accorded to the device.

Recording meters run slow on light loads, because at such loads the torque is relatively low and the friction load relatively high. If, after the calibration of the meter, this friction load is modified, then the light load accuracy of the meter is immediately affected, and as, for obvious reasons, the friction load may be said to never decrease, the meters tend, if they change at all, to run slow, not fast, on light loads.

It is obviously, therefore, to the advantage of the central station company to use every precaution to prevent the increase of the friction load, yet in due care in this particular central station managements very commonly fail.

These increases of friction may result from numerous causes. There are, however, three chief factors in the matter, which, when properly guarded against, will prevent any considerable trouble from slow meters. These are as follows:

1. The point of installation.
2. The manner of installation and proper adjustment at the point of installation.
3. The accumulation of dirt.

All three of these factors need careful attention, and by such attention the revenue impairing influences may be quite fully guarded against.

In the selection of the point of installation special care should be exercised to avoid vibration. The average meter is to-day installed in whatever location the wireman may have thought it best to leave the necessary loops, and in both domestic and other classes of service the point which is most convenient for the wireman is rarely the best place for the meter. The damage to light load meter accuracy by reason of vibration is much greater than is generally understood.

Wearing of the jewel results almost entirely in its initial stages from reciprocating and not rotary motion of the shaft. A very inconsiderable amount of vibration, especially if it be of the rhythmic kind, *i. e.*, such as results from moving machinery, will speedily set the shaft into motion vertically. By this action the carefully rounded shaft point is gradually hammered out of shape, and sooner or later the jewel becomes slightly chipped. As soon as the jewel becomes chipped, a kind of grinding action begins, and the rotary motion from this point onward carries forward the evil work which in its early stages was due purely to vibration.

These jewel troubles are, one might say, of a microscopic nature, but no magnifying glass is needed to detect the result upon the revenue, as many a central station knows.

Since vibration is not always avoidable, care should be exercised to see that meters are so constructed as to permit the ready renewal of both shaft point and jewel without the necessity of removing the meter from the point of installation.

The bad effect of vibration is not confined to the jewel and shaft point. It tends to gradually shake loose fine wire connections, and even occasionally to break off fine wire; and in meters having commutators it tends to cause sparking at the brushes, thereby building up an uneven surface on the commutator and increasing the friction factor.

The proper care and cleaning of meter commutators is dealt with quite fully a litte further on in this paper, but a careful selection of

point of installation should be regarded as the "ounce of prevention" which will make the "pound of cure" troy weight rather than avoirdupois.

First and above all things, it is important to find the point of least vibration, and if possible to put the meter at that point. The old steam engineer's trick of holding a pencil or rod between the teeth and pressing it firmly against the wall or point of support, is a good and ready means of determining the character of vibration.

In the average installation the point of least vibration will be found in or near the ground floor, not under the roof. In the average dwelling every heavy team that passes affects the meter more if it be in the garret than in the cellar.

In the metering of office buildings one should try and put the meter against a brick wall, and, above all, wooden partitions with banging doors should be avoided.

Again, in selecting the point of installation extremes of heat and cold, and points exposed to dust, dampness or chemical fumes, should be shunned. In domestic work many of the meters which are installed in garrets, especially when under tin roofs, are exposed to surprisingly high temperaiures in the summer and low temperatures in the winter. Cellars, unless peculiarly damp, are almost always better than garrets. Kitchens, pantries and the like are also bad places for meters, for there is no hiding place so dear to the elementary hearts of the various insects which haunt the abodes of man as the inside of a meter, and even though a meter be apparently bug proof, insects will find their way in and wax great and happy, thriving, perhaps, on their kindred of later coming.

Having selected the best point to place the meter, no small care should be used in putting it up. The location is seldom ideal, but much can, as a rule, be done to improve conditions by care in installing.

It is quite important that meters should be level, for they are calibrated in a level position, and friction is generally increased if they are not so installed. Where vibration cannot be avoided, meters can frequently be cushioned. Some few central station managements provide racks which carry the meter upon sponge rubber cushions, and these racks are used at all points where vibration is considerable. There is no doubt that this arrangement is wise wherever vibration cannot be avoided.

In installing meters in connection with motor service, the meter should be placed on the station side, not upon the motor side of the controlling switch. This is important, not only on direct current motors, but also in connection with all polyphase work. The reason why meters should be so placed is twofold :

All forms of recording wattmeters have potential windings of fine wire, the mechanical strength of which is, of course, low. Every time that the controlling switch is used this fine winding is cooled or heated, and the resulsing expansion and contraction causes the insulation of the fine wire to chafe and weaken, and occasionally actually breaks off the wire.

Again, when the main switch is pulled there is commonly a high potential back kick, which searches out any point of weak insulation, caused as a rule by the chafing just mentioned, breaking through and causing a burnout and rupture of the potential winding. The meter comes to a standstill, and repairs are necessary. Much, if not all, of this trouble could be avoided by placing the meter upon the service side of the switch.

Having installed the meter in a satisfactory location and in a careful manner, it should not be assumed that it will go on for an indefinite period, giving results of the highest accuracy without future care. Meters, like clocks and watches, need periodic care and attention, and the expenditure of a small amount of money for cleaning and inspecting will be found to have a gratifying effect upon the revenue, and will make the necessity of serious repairs a most unusual thing.

There are many mistaken ideas as to the time and care which it is necessary to give for the proper cleaning and periodic inspection of meters. The average meter should be visited for the purpose of cleaning and inspection from two to three times annually. On each visit of this kind the cover should be taken off, any dirt or dust which may have accumulated should be removed, not with a brush, but with a pair of bellows. The condition of the jewel should be tested by taking the shaft gently between the thumb and finger and moving it slowly and gently over the surface of the jewel cup. If the meter be one of those having permanent damping magnets, the inside of the poles of these magnets should be brushed off with a thin piece of magnetized steel cut into convenient shape. If the meter have a commutator it should be gently cleaned with a piece of narrow cotton tape, and the meter is ready to be closed up and will go on doing efficient work.

In testing the jewel as just described it will be noted that a perfect jewel feels smooth and glass-like, while a damaged one feels rough and gritty.

The cleaning of a meter in the way just described takes on the average only about five minutes, never more than ten—not a large expenditure to insure continued good operation.

It is not infrequently said that when visits are made as frequently as every four months there is seldom anything to correct, or any part which needs cleaning. This is generally true so far as the evidence of the eye goes.

Meter troubles, however, begin on a very small scale. One might almost say upon a microscopic scale. But the trouble, having once found a footing, increases in magnitude with great rapidity, and it is to remove the causes of trouble in their initial stages, when they are easy to reach, that frequent cleaning and inspection is recommended.

There is, oddly enough, one particular little "Don't" on these periodic visits to meters which is done all too often. The meter should not be oiled. The merest film of oil upon the jewel lasts for an indefinite period. More than a film is detrimental, as is oil at any other portion of the mechanism. The light-load accuracy of hundreds of meters has been ruined by what was regarded as a conscientious use of oil. Better no oil at all than too much.

As to the testing of meters, it is the common impression that meters should be removed from the point of installation and taken to the station or the laboratory in order to be given a proper test. In reality this should be necessary only in rare cases, and this particular fact should be borne in mind when installing, and meters should always be placed in situations where they are reasonably accessible and not absolutely in the dark.

Meters are tested on the average system for one of two reasons—either because of a complaint on the part of the customer, who claims that his meter is too fast, or from a suspicion on the part of the central station management that the meter is under-recording. Customers' complaints are very common in the winter, when the bills are normally high, and it will generally be found that about 95 per cent. of the complaints originating with customers are without foundation.

Tests necessitated by suspicion of slow operation are, generally speaking, more important, because they are more commonly founded upon actual existing conditions. There are half a dozen methods for testing meters at the point of installation, and all of them are more or less satisfactory. One or more of these methods should be used on every occasion before resorting to the removal of the meter, which should be regarded only as a last resort, in case the meter proved to have defects which cannot be remidied *in situ*.

In testing meters in response to a customer's complaint, where the central station management does not share in a customer's distrust of the meter's accuracy, it is frequently only necessary to make a rough lamp test; but this form of test should be used only if the central station management has every reason to believe the meter is accurate.

The lamp method of test merely necessitates putting a definite number of lamps upon the meter, multiplying this number of lamps by the watts per lamp if the meter under test be a wattmeter; or by the current per lamp in amperes if the meter under test be an ampere meter, thus determining approximately the total load in watts or amperes under which the meter is operating. By using the proper formula (and there is a simple formula of this kind for every commercial form of rocording meter), the speed at which the meter should revolve at this particular load can be immediately determined. The actual speed of the meter for 1, 10 or 100 revolutions should then be taken with a stop-watch, and any discrepancy which there may be between the theoretic and the actual time per revolution at once shows what percentage of error there may be in the record of the meter. This method is, of course, only an approximate one. It may be regarded under average conditions as being within, say, 6 per cent., the source of error arising in the probability of variation of actual from theoretic watts or amperes per lamp.

The above method of test can quite frequently be reversed with quite dramatic effect, when testing for peculiarly suspicious customers, by instructing the customer to turn on a number of lamps known to him, but unknown to the tester, who can then time the meter and tell the customer, with little probability of error, how many lamps are burning.

The lamp method of test should not be used where the central station management has any reason whatever for doubting the accuracy of the meter; nor should it be used in connection with the settlement of disputes of any great magnitude or importance. It is not sufficiently absolute.

Some positive means should be used for determining the actual energy or current passing through the meter. If there be no inductive loads this can be done very readily with an ampere meter in series with the recording meter on the load side and a voltmeter across the line on the station side of the recording meter. Or, if the recording meter be an ampere hour, the ammeter alone will be needed.

It is yet better and easier to use an indicating wattmeter of one of the several accurate and reliable types now procurable, which, on being connected in series with the meter under test, read directly in watts the load which the meter is carrying.

A third and generally very satisfactory method of testing suspected meters consists in using a light, portable, perforated box, having, say, six calibrated incandescent lamps on the inside, varying from 16 to 50-candle power, and all connected to two binding posts on the outside of the box, each lamp being controlled independently by a snap switch also on the outside of the box. The lamps used should be selected of a voltage of from 4 to 6 volts higher than the normal maximum potential of the service upon which they are to be used, and they should then be carefully measured individually and the energy used in each lamp established and marked upon a calibration card by 1-volt steps, beginning at the minimum and running up to the maximum likely to be met with upon the system.

By connecting this set of portable lamps as the sole load upon the meter, and measuring the potential with a small portable voltmeter, it is only necessary to refer to the calibration card of the lamps to determine just what load the meter is operating upon. This system has the advantage of providing an extremely flexible testing load, and as the test lamps are used only for brief periods and on potentials below those for which they are constructed, they will retain their calibration for a long time, although they should, of course, be remeasured with reasonable frequency.

By testing meters at the point of installation much time and expense can be saved, and cases where the removal of the meter is necessary will be found to be very rare, especially if a proper system of care and cleaning is enforced ; for such errors as are discovered will almost always be directly traceable to trivial mechanical faults and can be remedied promptly without taking the meter down at all.

The inaccurate reading of meters has in the past been a prolific source of error and dispute, and in less but still serious degree this is yet true. Meter reading should be the work of cheap men, but cheap men can seldom be relied upon to practice due care in the reading, if they be intrusted literally with the duty of translating the showing upon the dial.

The reading of a meter dial, whether it be a gas, water or electric dial, is always somewhat puzzling, and in some positions difficult even to the initiated. The actual translation of the dial indication should not be intrusted to the men who visit the meters to take their state. These men should go no further than to mark with a pencil the position of each hand upon a printed diagram of the dial. This the most unintelligent can do with sufficient accuracy, and the average man can read, or rather take, the state of 75 per cent. more meters a day in this way than if he attempt to actually translate into figures.

The diagrams of a day's reading should all be read at the office by a competent person skilled in the rapid translation of meter dial records. By this means almost every liability of error is removed, and in addition the central station management has the best of evidence as to the actual state of the meter for use in case of subsequent disputes.

Probably the most useful and satisfactory system of meter dial records is that which provides cards for each meter customer, good for a six months' record, bearing at the top space for the insertion of the customer's name, the meter number, the constant, and such other information as the central station management may find helpful in quick reference, as, for example, the capacity of the meter, number of lamps connected, the potential, and always a space for remarks.

Beneath these headings should be six diagrammatic reproductions of the meter dial ready for marking, and beneath each separate diagram should be provided a place for inserting "Indication," "Last reading," "Consumption," and, with ample space, "Remarks."

The meter reader takes his route by the cards which are handed to him in the morning, and his duty consists solely in marking the position of the hand on the diagram for the month, entering the date of reading under or opposite that diagram. The remainder of the work is done at the office, and the cards, always up to date, furnish an immediate means of reference when systematically arranged, as they should be, in a filing drawer.

Most central station managements have found that the bulk of all the complaints which they receive come in during the winter months, when the bills are, of course, heaviest. Some central stations have found it very helpful, therefore, to make their winter months shorter and their summer months longer arbitrarily. Thus, the October reading may be taken November 5, the November reading December 2, the December reading January 1, the January reading January 30, and the February reading February 27. A system of this kind tends slightly to even up the months, making the summer and winter bills not quite so disproportionate as they might otherwise be, and yet works no injustice to the customer.

In the management of a meter system relative success or failure rests in attention to little things, and an illuminating company changing from a system of little or no care to a system carefully arranged to provide for proper attention to all of the small details will find that the resulting change in revenue will be most marked ; sometimes, indeed, it will be found to be so great as to be an important factor in the ability of the company to pay satisfactory dividends.

Extensions to the Plant of the Niagara Falls Power Company.

The New York *Sun*, for the 7th inst., says that the Niagara Falls Power Company is extending its wheel pit and power house in order to provide facilities for developing 35,000-horse power in addition to the 15,000 already in use, while the Niagara Falls Hydraulic Power and Manufacturing Company is arranging for 12,500 additional horse power, while over on the Canadian side of the river, in Queen Victoria Park, the Canadian Niagara Power Company is making a temporary development of at least 1,500-horse power.

The Niagara Falls Power Company's new pit is 179 feet deep and about 275 feet in length. In this extension seven more 5,000-horse power turbines are to be installed, making ten in all, which will develop 50,000-horse power. The power station, the original section of which was 140 feet long, has been extended over the entire wheel pit, and its total length is about 426 feet. The outer surface of the extension of the building is of limestone of the same quality as the original section, and the inner walls for a height of 6 feet from the floor are of enameled brick, while above this point they are of ordinary brick, covered with white enamel paint. The designs for the original building were made by McKim, Mead & White, of New York, and in building the extension the style of architecture so much admired in the first section has been closely followed. Under the one roof of this great power station 50,000 electrical horse power will be available soon. This will make it the greatest electrical power station in the world; but even this amount of power will exhaust only one-half the resources of the Company. When the tunnel, which acts as a tail race to carry the water from the turbines, was constructed, it was intended for a plant of 100,000-horse power capacity, and the additional 50,000-horse power to be developed in connection with it will be made available through a second power house to be built on the opposite side of the inlet canal. The line of the roof of the power station is unbroken by chimneys. This is because the building is heated throughout by electricity, it being the largest structure in the world so heated. The 50-ton electric crane installed in the first section of the power house will run the entire length of the interior of the building and aid in installing the additional turbines in the pit and the additional generators in the power house.

A serious danger was discovered in the wheel pit last summer. This was a creeping of the walls of the pit. The great stone sides were found to be gradually coming together, and thus endangering the valuable installation placed between them. About half-way down the pit the rock was beginning to creep, as geologists describe the action, and a dangerous situation confronted the Company. The experience of eminent engineers was called into service to ascertain the cause, but on August 15 the creeping ceased as suddenly as it had begun. The matter, nevertheless, caused great anxiety, and led the Company to take steps to brace the walls of the pit. Twenty struts or columns, each 18 feet long and 30 inches in diameter, have been made, and these will be placed in the pit. The struts are hollow, and will rest on iron bases 3 feet 6 inches square and 18 inches high, and these bases will be fastened with anchor bolts to the walls. It is expected that they will prevent all future creeping of the rocky walls of the pit. In order to make the pit still more substantial, it has been lined to a height of about 40 feet from the bottom with brick, which will prevent the soft stratum of rock underneath from washing away. In the course of time, after the turbines have been installed, it is the intention of the Company to extend the brick walls to the top of the pit, while the old section of the pit will be similarly treated, it is understood.

A small portion of the product of the Company is transmitted to

Buffalo over copper cables. In the transformer house at Niagara Falls adjoining the power station, men are busy installing additional transformers, so that the voltage of the power to be sent to Buffalo may be raised from 2,000 to 11,000, at which voltage the transmission is more economical. In all, these transformers will number ten, each having a capacity of 1,250-horse power. The transmission line to Buffalo is 26 miles long, and the number of cables on it has just been increased to 6, or two 3-phase lines. The three cables last placed are identical with the first three, and have been strung on the upper crossarms of the poles. They have 19 strands, and each is of 350,000 circular mils. As the length of each cable is about 26 miles, the length of the 6 cables is about 150 miles, which requires a large amount of copper. At the Buffalo end of the line additional step down transformers are being installed to reduce the voltage before it is supplied to customers.

The men interested in the Canadian Niagara Power Company are practically the same as those connected with the Niagara Falls Power Company, and for the rights which they hold there they pay an annual rental of $25,000. Under its agreement the Canadian Niagara Power Company is to have completed water connections for the development of 25,000-horse power by November 1 next, and to have actually ready for use, supply and transmission 10,000 developed horse power by the same date. By replying to an actual or fancied demand for power, the Company has arranged for the development of 500 horse power in the station of the Niagara Falls Park and River Railway, which is now available, and also for the placing of a generator of 1,000-horse power capacity in the same station, the latter power to be available in the spring. The Power plant of the Niagara Falls Hydraulic Power Manufacturing Company is located at the water's edge in the gorge. The water that operates the turbines is conducted from the upper Niagara through a surface canal to a basin on the high bank, about 300 feet back from the bluff. For several years the work of enlarging this plant, in accordance with rights granted by the State Legislature, has been in progress, until now the installation is notable. At the entrance the canal of this Company is 250 feet wide, and it narrows to 100 feet in the first 400 feet of its length, and then to 70 feet. It is through this surface canal that the water flows to the canal basin. Various mills are supplied with water for power purposes from this basin, while a short canal carries a portion of the water to a forebay, which is located still nearer the edge of the bluff, and from which the water to operate the turbines in the power house in the gorge is taken through huge penstocks. The original section of this power station was 60 by 100 feet, and an extension is now building of the same size, making the dimensions of the station 100 by 120. In the old section of this station there are eight generators operated by four turbines, and in the new section five wheels, each of 2,500-horse power capacity, are to be installed to operate generators. The first wheel to be installed in this new section will operate a generator which will supply electric current for the operation of the National Electrolytic Company's new chlorate of potash works on the high bank above. The other wheels will be placed as the demand for power makes their service necessary.

This activity in developing power at Niagara is very notable and well portrays the success of the several power projects to be found here. It also makes clear how rapidly electricity is winning its way in competition with steam power.

Changes in the Patent Laws.

Messrs. Howson & Howson, of Philadelphia, are the compilers of the following information respecting radical changes now in force in the Patent Laws of the United States:

1. A radical change is made in Section 4,887 of the Revised Statutes, affecting the interests of those taking out, or desiring to take out, foreign patents. The section, as revised, reads as follows (the new parts being printed in brackets):

"Sec. 4,887. No person [otherwise entitled thereto] shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid, by reason of its having been first patented or caused to be patented [by the inventor or his legal representatives or assigns] in a foreign country [unless the application for said foreign patent was filed more than seven months prior to the filing of the application in this country, in which case no patent shall be granted in this country]."

It will be seen that the long standing requirement that "every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent" will be abolished, so that all patents granted under the new law will run for the full term of 17 years. Furthermore, under the new law, an inventor can apply for his foreign patents without waiting for the allowance of his U. S. application, or arranging for the issuance of his U. S. patent. In fact, he can file his foreign application simultaneously with, or even before, the filing of his American application. On the other hand, there has been added a limitation, whose practical effect will be to cause a foreign patentee to forfeit his right to a U. S. patent unless he shall file his American application within seven months after the filing of his foreign application.

2. A new defense can be set up to an action for infringement of a patent granted under the new law, namely: "That it (the invention) has been patented or described in some printed publication * * * more than two years prior to his application for patent therefor." Such two years' prior publication or patenting of an invention will bar the grant of a valid patent for the invention under the new law. (Sec. 4,886 and Sec. 4,920, R. S.)

3. Under the law as amended, the time within which an applicant for a patent is required to proceed with his application in the Patent Office is reduced from two years to one year after any official action thereon. (Sec. 4,894, R. S.)

Note.—The act provides that the above-mentioned amendments "shall not apply to any patent granted prior to January 1, 1898, nor to any application filed prior to said date, nor to any patent granted on such an application."

4. The act of March 3, 1897, also put in force a Statute of Limitation, as follows:

"But in any suit or action brought for the infringement of any patent there shall be no recovery of profits or damages for any infringement committed more than six years before the filing of the bill of complaint or the issuing of the writ in such suit or action, and this provision shall apply to existing causes of action." (Sec. 4,921, R. S.)

On the Solubility of Ammonia in Water at Temperatures Below 0° C.

By J. W. Mallet, in *Am. Chem. Journal.*

Roscoe and Dittman's table[1] of the solubility of ammonia in water at different temperatures, under normal pressure, begins at 0° C., and there seems to be no recorded measurements of solubility at any lower temperatures. It is stated on the authority of Fourcroy and Vanquelin[2] that a "concentrated" aqueous solution of ammonia—the exact amount in solution not given; probably not determined—does not freeze till cooled between—38° and —41°, that it then forms brilliant flexible needles, and that at —49° it solidifies to a gray gelatinous mass, almost destitute of odor.

It seems interesting to try the effect of continuing to pass gaseous ammonia into an already strong aqueous solution at temperatures much below zero, and particularly to see whether any visible change of behavior would mark the presence of enough ammonia to represent the hydroxide of ammonium, often assumed to exist in the ordinary solution, but without any surplus water. The proportion in question—one molecule of ammonia for one of water, might, from an inspection of Roscoe and Dittmar's table, be expected to occur at a temperature but little below zero. Taking advantage of a fall of finely pulverulent dry snow, followed by two or three days of cold weather, during which the atmospheric temperature was about —8° to —12° C., the following experiments were made last winter. In anticipation of such an opportunity, the apparatus had been made ready some time before.

A strong solution of ammonia in water was placed in a burette-like glass tube of the form shown in Fig. 1, of which the larger cylindrical part was about 220 m.m. long and 25 m.m. in internal diameter, the narrow tube below about 100 m.m. long and only about 1 m.m. in internal diameter, with a small glass stopcock about 30 m.m. above the orifice. The cylinder was graduated for about two thirds of its length into cubic centimeters. By means of an india rubber stopper, perforated to grasp tightly the narrow tube, and then cut in two in the line of its axis, this part of the burette was fixed in the neck of an inverted gas jar, the body of which was about 180 m.m. high, with an internal diameter of about 120 m.m., so that the cylindrical body of the burette could be surrounded by a freezing mixture contained in the jar, without any leakage occurring at the neck, the narrow—almost capillary—tube and stopcock being below and outside the jar. The open mouth of the burette above was loosely closed by a doubly-perforated stopper,

1. *J. Chem. Soc.*, xii., 128—quoted in Roscoe and Schorlemmer's "Treatise on Chemistry," i., 385.

2. Gmelin's "Handbook of Chemistry" (Cavendish Soc. transl.), ii., 425.

through which passed a small tube for the introduction of ammonia gas, and an alcohol thermometer, each fitting so as to be easily slid up or down. The thermometer was carefully made by Mr. Henry J. Green, of Brooklyn, N.Y., contained pure (uncolored) alcohol, was graduated on the glass stem and had the (centigrade) scale verified by comparison with a (Fahrenheit) mercurial thermometer, itself tested by comparison with a gas thermometer, at the following points: +32°, +12°, —8°, and —28° F. The gaseous ammonia was obtained by simply heating in a flask the strong aqueous solution. There was, of course, no need for drying it, but it was cooled, and incidentally in large measure dried, by passing it first through an empty flask surrounded by snow, and then through a spiral coil of glass tubing immersed in a bath of snow and common salt. Thence by an india rubber connecting tube it passed into the already strong solution in water contained in the burette. This was surrounded in the jar by a freezing mixture of snow and commercial hydrochloric acid, both materials having been separately cooled down in advance by snow and salt. In consequence of the evolution of heat as more ammonia was absorbed by the water in the burette, it became necessary to allow ample time for cooling down again, and to renew the freezing mixture in the jar, drawing off the old mixture by means of a specially arranged and rapidly-acting siphon. In order to get the lowest temperature reached (between —45° and —46° C.) it was necessary to doubly cool the last portions of snow and hydrochloric acid, first by snow and salt, and then by separate exposure to some of the already cooled snow and hydrochloric acid mixture. The passage of the gas into the solution was continued until it went through very freely unabsorbed, the liquid in the burette continually increased in volume, so that, when samples were drawn off by the stopcock, enough was run off to effectually cool the projecting part of the narrow tube and the stopcock itself, and to bring the level of the remaining liquid down to one of the graduation marks, from which a measured sample might then be taken off. A number of light glass flasks, each of about 300 c.c. capacity, furnished with stoppers, were in advance about three-fourths filled with water and severally weighed with accurrcy on a good analytical balance. These flasks of water were brought down to 0° C. by immersion in snow, and—operating out of doors—the several samples of liquid ammonia were run into them from the burette, producing at once such large dilution that there was no further fear of loss of ammonia by standing over, with the stoppers inserted, until the flasks could be re weighed—the gain of weight in each case representing the amount of liquid taken from the burette—and the amount of real ammonia determined by neutralization with a standard solution of sulphuric acid. The first sample was taken at —40° C., and then, by simply removing the freezing mixture of snow and hydrochloric acid from the jar, the temperature of the liquid in the burette was allowed to slowly rise, and as the thermometer marked different desired points it was raised for a moment out of the liquid, another sample drawn off into the water in one of the flasks beneath, and the thermometer lowered again. One or two fairly good measurements of the volumes of the samples were made, but, owing to the necessity for quick work, and the difficulty of seeing satisfactorily through the dimmed surface of the glass, most of these measurements were little to be relied on.

The following results were obtained, so expressed as to form a continuation of Roscoe and Dittmar's table. The atmospheric pressure at the time was 743—744.5 m.m., corrected for temperature of the mercurial column.

At —10° C. 1 grm. of water dissolved 1.115 grms. of ammonia.
At —20° C. 1 grm. of water dissolved 1.768 grms. of ammonia.
At —30° C. 1 grm. of water dissolved 2.781 grms. of ammonia.
At —40° C. 1 grm. of water dissolved 2.946 grms. of ammonia.

The taking up of enough ammonia to form ammonium hydroxide was not attended with any apparent change of behavior, and continuous liquefaction went on smoothly to the lowest temperature reached, with no separation of any solid product. After the freezing mixture had been withdrawn the temperature rose at first very gradually in consequence of rapid surface evaporation of ammonia. At —25° C. (barometer at 743.4 m.m., corr.), steady but not tumultuous ebullition took place and continued for several minutes. A sample taken at this point had the composition: 1 grm. of water and 2.554 grms. of ammonia.

By interpolation from Regnault's results, the tension of the vapor from liquefied ammonia at —25.6° C. would be about 1,167 mm.

A sample was also taken at —3.9°, which proved to consist of 1 grm, of water and 0.947 grm. of ammonia—the last corresponding almost exactly with the calculated proportion for ammonium hydroxide, and agreeing also quite closely with an extension of Roscoe and Dittmar's table to the temperature named, allowance being made for the pressure being a little below normal.

Fig. 1.

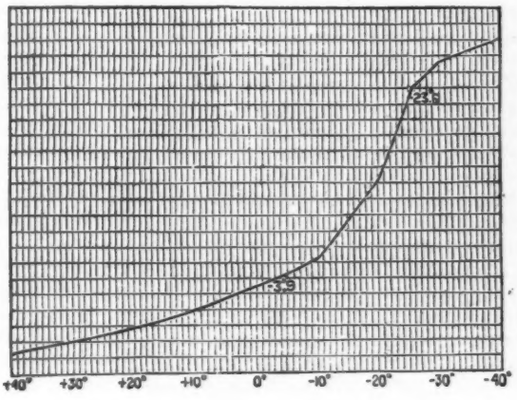


Fig. 2.

These results are graphically plotted in Fig. 2, which includes also the determination of Roscoe and Dittmar for + 40° to 0°. It will be seen that the curve changes rapidly a little below the temperature corresponding to the formation of $(NH_4)OH$, and the amount of ammonia absorbed is much greater than would be called for by an extension of Roscoe and Dittmar's numbers.

As regards the reversal of curvature before — 30° is reached, some allowance must doubtless be made for loss of ammonia by the samples drawn at the lowest temperatures in dropping through the air into the icewater in the flasks in spite of the precautions taken to minimize loss from this source. And, in view of the fact that liquefied ammonia boils at —33.7° under a pressure of 749.3 mm. (Bunsen), the amount of ammonia found in the contents of the burette below this point would, of course, go on increasing indefinitely, depending simply on the length of time allowed for condensation and the more or less free supply of the gas. It appears that ammonium hydroxide, if such a substance exist, or the solution of ammonia in water in proportion corresponding to such a compound, continues to dissolve gaseous ammonia, or mixes with liquefied ammonia, down to and beyond the normal boiling point of the latter, but the proportion dissolved is much greater than would be called for by an extension of the curve representing solubility at temperatures above 0°.

As has been stated, measurement of the volumes of the samples taken

could not be very satisfactorily carried out. It may be mentioned, however, that a comparison of volume with weight gave for the liquid at — 30° a density of about 0.718, and for that at — 40° about 0.731, as referred to water at + 4°. The latter figure being greater than the former may probably be accounted for by the very high value of the coefficient of dilatation for liquefied gases. Calculating from Jolly's results, the density of liquefied ammonia itself at — 40° ought to be something like 0.673.

On the Densities of Carbonic Oxide, Carbonic Anhydride, and Nitrous Oxide.

[A paper read by LORD RAYLEIGH, F.R.S., before the Royal English Society.]

The observations here recorded were carried on by the method and with the apparatus described in a former paper ("On the Densities of the Principal Gases," *Roy. Soc. Proc.*, liii., p. 134, 1893), to which reference must be made for details. It must suffice to say that the globe containing the gas to be weighed was filled at 0° C, and to a pressure determined by a manometric gauge. This pressure, nearly atmospheric, is slightly variable with temperature on account of the expansion of the mercury and iron involved. The actually observed weights are corrected so as to correspond with a temperature of 15° C. of the gauge, as well as for the errors in the platinum and brass weights employed.

In the present as well as in the former experiments I have been ably assisted by Mr. George Gordon.

Carbonic Oxide.—This gas was prepared by three methods. In the first method a flask, sealed to the rest of the apparatus, was charged with 80 grms. recrystallized ferrocyanide of potassium and 360 c.c. strong sulphuric acid. The generation of gas could be started by the application of heat, and with care it could be checked and finally stopped by the removal of the flame with subsequent application, if necessary, of wet cotton-wool to the exterior of the flask. In this way one charge could be utilized with great advantage for several fillings. On leaving the flask the gas was passed through a bubbler containing potash solution (convenient as allowing the rate of production to be more easily estimated), and thence through tubes charged with fragments of potash and phosphoric anhydride, all connected by sealing. When possible, the weight of the globe *full* was compared with the mean of the preceding and following weights *empty*. Four experiments were made with results agreeing to within a few tenths of a m.grm.

In the second set of experiments the flask was charged with 100 grms. of oxalic acid and 500 c.c. strong sulphuric acid. To absorb the large quantity of CO_2 simultaneously evolved a plentiful supply of alkali was required. A wash bottle and a long, nearly horizontal tube contained strong alkaline solution, and these were followed by the tubes containing solid potash and phosphoric anhydride as before.

For the experiments of the third set *oxalic* acid was replaced by *formic*, which is more convenient as not entailing the absorption of large volumes of CO_2. In this case the charge consisted of 50 grms. formate of soda, 300 c.c. strong sulphuric acid, and 150 c.c. distilled water. The water is necessary in order to prevent action in the cold, and the amount requires to be somewhat carefully adjusted. As purifiers, the long, horizontal bubbler was retained, and the tubes charged with solid potash and phosphoric anhydride. In this set there were four concordant experiments. The immediate results stand thus:

Carbonic Oxide.

From ferrocyanide	2.29843
" oxalic acid	2.29852
" formate of soda	2.29854
Mean	2.29850

This corresponds to the number 2.62704 for oxygen (*loc. cit.*, p. 144), and is subject to a correction (additive) of 0.00056 for the diminution of the external volume of the globe when exhausted.

The ratio of the densities of carbonic oxide and oxygen is thus 2.29906 : 2.62760; so that if the density of oxygen be taken as 32, that of carbonic oxide will be 27.9989. If, as some preliminary experiments by Dr. Scott (*Camb. Phil. Proc.*, ix., p. 144, 1896) indicate, equal volumes may be taken as accurately representative of CO and of O_2, the atomic weight of carbon will be 11.9989 on the scale of oxygen = 16.

The very close agreement between the weights of carbonic oxide prepared in three different ways is some guarantee against the presence of an impurity of widely differing density. On the other hand, some careful experiments led Mr. T. W. Richards (*Amer. Acad. Proc.*, xviii., p. 279, 1891) to the conclusion that carbonic oxide is liable to contain considerable quantities of hydrogen or of hydrocarbons. From 5½ liters of carbonic oxide passed over hot cupric oxide he collected no less than 25 m.grms. of water, and the evidence appeared to prove that the hydrogen was really derived from the carbonic oxide. Such a proportion of hydrogen would entail a deficiency in the weight of the globe of about 11 m.grms., and seems improbable in view of the good agreement of the numbers recorded. The presence of so much hydrogen in carbonic oxide is also difficult to reconcile with the well known experiments of Professor Dixon, who found that prolonged treatment with phosphoric anhydride was required in order to render the mixture of carbonic oxide and oxygen inexplosive. In the presence of relatively large quantities of free hydrogen (or hydrocarbons) why should traces of water vapor be so important?

In an experiment by Dr. Scott (*Chem. Soc. Trans.*, 1897, p. 564) 4 liters of carbon monoxide gave only 1.3 m.grms. to the drying tube after oxidation.

I have myself made several trials of the same sort with gas prepared from formate of soda exactly as for weighing. The results were not so concordant as I had hoped,[1] but the amount of water collected was even less than that given by Dr. Scott. Indeed I do not regard as proved the presence of hydrogen at all in the gas that I have employed.[2]

Carbonic Anhydride.—This gas was prepared from hydrochloric acid and marble, and, after passing a bubbler charged with a solution of carbonate of soda, was dried by phosphoric anhydride. Previous to use, the acid was caused to boil for some time by the passage of hydrochloric acid vapor from a flask containing another charge of the acid. In a second set of experiments the marble was replaced by a solution of carbonate of soda. There is no appreciable difference between the results obtained in the two ways; and the mean, corrected for the errors of weights and for the shrinkage of the globe when exhausted, is 3.6349, corresponding to 2.6276 for oxygen. The temperature at which the globe was charged was 0° C., and the actual pressure that of the manometric gauge at about 20°, reduction being made to 15° by the use of Boyle's law. From the former paper it appears that the actual height of the mercury column at 15° is 762.511 mm.

Nitrous Oxide.—In preliminary experiments the gas was prepared in the laboratory, at as low a temperature as possible, from nitrate of ammonia, or was drawn from the iron bottles in which it is commercially supplied. The purification was by passage over potash and phosphoric anhydride. Unless special precautions are taken the gas so obtained is 10 or more m.grms. too light, presumably from admixture with nitrogen. In the case of the commercial supply a better result is obtained by placing the bottles in an inverted position so as to draw from the *liquid* rather than from the *gaseous* portion.

Higher and more consistent results were arrived at from gas which had been specially treated. In consequence of the high relative solubility of nitrous oxide in water, the gas held in solution after prolonged agitation of the liquid with impure gas from any supply will contain a much diminished proportion of nitrogen. To carry out this method on the scale required, a large (11 liter) flask was mounted on an apparatus in connection with the lathe so that it could be vigorously shaken. After the dissolved air had been sufficiently expelled by preliminary passage of N_2O, the water was cooled to near 0° C., and violently shaken for a considerable time while the gas was passing in large excess. The nitrous oxide thus purified was expelled from solution by heat, and was used to fill the globe in the usual manner.

For comparison with the results so obtained, gas purified in another manner was also examined. A small iron bottle, fully charged with the commercial material, was cooled in salt and ice, and allowed somewhat suddenly to blow off half of its contents. The residue drawn from the bottle in one or other position was employed for the weightings.

Nitrous Oxide (1896).

Aug. 15—Expelled from water	3.6359
" 17—	3.6354
" 19—From residue after blow off, valve downwards,	3.6364
" 21— " " " upwards	3.6358
" 22— " " " downwards,	3.6360
Mean	3.6359

1. One obstacle was the difficulty of re-oxidizing the copper reduced by carbonic oxide. I have never encountered this difficulty after reduction by hydrogen.

2. In Mr. Richard's work the gas, in an imperfectly dried condition, was treated with hot platinum-black. Is it possible that the hydrogen was introduced at this stage?

The mean value may be taken to represent the corrected weight of the gas which fills the globe at 0° C. and at the pressure of the gauge (at 15°), corresponding to 2.6276 for oxygen.

One of the objects which I had in view in determining the density of nitrous oxide was to obtain, if it were possible, evidence as to the atomic weight of nitrogen. It may be remembered that observations upon the density of pure nitrogen, as distinguished from the atmospheric mixture containing argon which, until recently, had been confounded with pure nitrogen (Rayleigh and Ramsay, *Phil. Trans.*, Vol. clxxxvi., p. 190, 1895), led to the conclusion that the densities of oxygen and nitrogen were as 16 : 14.003, thus suggesting that the atomic weight of nitrogen might really be 14 in place of 14.05, as generally received. The chemical evidence upon which the latter number rests is very indirect, and it appears that a direct comparison of the weight of nitrous oxide and of its contained nitrogen might be of value. A suitable vessel would be filled, under known conditions, with the nitrous oxide, which would then be submitted to the action of a spiral of copper or iron wire rendered incandescent by an electric current. When all the oxygen was removed, the residual nitrogen would be measured, from which the ratio of equivalents could readily be deduced. The fact that the residual nitrogen would possess nearly the same volume as the nitrous oxide from which it was derived would present certain experimental advantages. If indeed the atomic weights were really as 14 : 16, the ratio (x) of volumes, after and before operations, would be given by—

$$\frac{2\ 2996 \times x}{3.6359 - 2.2996 \times x} = \frac{14}{8},$$

whence—

$$x = \frac{7 \times 3.6359}{11 \times 2.2996} = 1.0061,$$

3.6359 and 2.2996 being the relative weights of nitrous oxide and of nitrogen which (at 0° C. and at the pressure of the gauge) occupy the same volume. The integral numbers for the atomic weights would thus correspond to an expansion, after chemical reduction, of about one-half per cent.

But in practical operation the method lost most of its apparent simplicity. It was found that copper became unmanageable at a temperature sufficiently high for the purpose, and recourse was had to iron. Coils of iron suitably prepared and supported could be adequately heated by the current from a dynamo without twisting hopelessly out of shape; but the use of iron leads to fresh difficulties. The emission of carbonic oxide from the iron heated in vacuum continues for a very long time, and the attempt to get rid of this gas by preliminary treatment had to be abandoned. By final addition of a small quantity of oxygen (obtained by heating some permanganate of potash sealed up in one of the leading tubes), the CO could be oxidized to CO_2, and thus, along with any H_2O, be absorbed by a lump of potash placed beforehand in the working vessel. To get rid of superfluous oxygen, a coil of incandescent copper had then to be invoked, and thus the apparatus became rather complicated.

It is believed that the difficulties thus far mentioned were overcome, but nevertheless a satisfactory concordance in the final numbers was not attained. In the present position of the question no results are of value which do not discriminate with certainty between 14.05 and 14.00.

The obstacle appeared to lie in a tendency of the nitrogen to pass to higher degrees of oxidation. On more than one occasion mercury (which formed the movable boundary of an overflow chamber) was observed to be attacked. Under these circumstances I do not think it worth while to enter into further detail regarding the experiments in question.

The following summary gives the densities of the various gases relatively to air, all obtained by the same apparatus (*Roy. Soc. Proc.*, vol. liii., p. 148, 1893; vol. lv., p. 340, 1894; *Phil. Trans.*, vol. clxxxvi., p. 189, 1895; *Roy. Soc. Proc.*, vol. lix., p. 201, 1896). The last figure is of little significance—

Air free from H_2O and CO_2	1.00000
Oxygen	1.10535
Nitrogen and argon (atmospheric)	0.97209
Nitrogen	0.96737
Argon	1.37752
Carbonic oxide	0.96716
Carbonic anhydride	1.52909
Nitrous oxide	1.52951

The value obtained for hydrogen upon the same scale was 0.0696; but the researches of M. Leduc and of Professor Morley appear to show that this number is a little too high.

The Relation of the Mining Engineer to the Economic Operation of Coal Mines.

[A paper read by MR. S. A. TAYLOR, before the Central Mining Institute of Western Pennsylvania.]

In these days of close competition in trade we find the wide awake successful business man is the one who avails himself of modern improvements to facilitate the operations of his business. The cause of this is clear. Our country, within the short period of its existence, has developed from a primitive to a well-established and highly commercial nation, until at present we have almost all of the necessities of life and many of the luxuries produced within our own borders, and the development has been such that now, in almost every line of industry, we find enough competition to make the race for business or trade such that in order to secure the same, prices must be cut down to the lowest notch. It is this competition which has brought forth the economist in his branch of business, be that what it may, and the mining industry is no exception in this onward march.

But, in order to bring this more forcibly to our minds, let us take in a general way, avoiding statistics as much as possible, the growth of the iron trade; the twin sister of the coal trade, and particularly the steel rail branch thereof. It is within the remembrance of most of those here when steel rails were sold at a price which would seem princely compared to that of to-day. I need only refer to the early 70's, when steel rails sold for $65 and $70 per ton, and were considered phenomenally low at $40 in the period from 1873 to 1879. Compare that with contracts filled by the Carnegie Company during the last year, viz., $17 per ton and less at works, which is between two-fifths and one-fourth as much as in former days. Now, why was such a thing possible? Was it because it took more work, as measured by units, to convert a ton of steel from the ore to finished product in the 70's than it does now? Generally speaking, no; but strictly speaking, yes. In those days one of the finest (if not the finest) steel rail plants in this country went through about the following process, which is known in its second stage as the Bessemer process.

Beginning at the furnace, we omit the question of getting the ore to that point, which in itself is a subject which would require much more than the time allotted for this paper. But on this line suffice it to say that new and economical machinery for the mining and handling of ores, fuels, etc., as well as the transportation of same, has been, to a large extent, the means of producing and laying down in the yards of the furnace to day, materials superior in quality at a much less cost per ton than in the early days. With these materials at hand they charged the furnace with the ore, the fuel, and the fluxes, with great losses of heat, etc., at this point by the escaping of gas and chilling of the furnace. The metal thus produced was in the form of a molten mass which was run out into molds forming pigs and cooled, then loaded in cars and shipped to the metal yards at the converting mill, where it was again unloaded, wheeled into the mill to the converters, and here put by hand into the converter. There this cold metal had to be again heated and decarbonized, and recarbonized by the receiving of more cold metal, in the form of spiegel or manganese which again must be heated to a uniform mass. It was now ready for pouring into molds, forming ingots, which were in turn taken to the blooming mill, and by hand put into furnaces or soaking pits, there to be reheated and rolled into blooms which were subsequently cut into pieces large enough to make a 30 foot rail. These billets were then charged into a furnace, reheated and rolled into rails, these in turn to be straightened, bored and handled onto the shipping beds. All these operations were largely executed by muscular force. But what marvelous changes greet one when he steps into one of the establishments of to-day. There you behold the furnace not in its embryonic state (if you will permit the expression), but equipped with modern machinery for unloading the ores, and conveying the same to the top of the furnace. Instead of the old single bell cone, you find a chamber fitted with a double bell cone, and there are all the gases which formerly passed into the air are made to heat up the cold materials and then pass back down large conduits into the stove again. And when the metal is ready, instead of it being poured out into molds it is run into cars made for its reception, in which it is hauled direct to the converting mill, and here run into the cupola hot, thus avoiding four handlings of the metal. All of this is a great saving of time and labor, for the modern converting mill of to-day will turn out about five tons to one by the old process with the saving of hundreds of men and thousands of dollars in money.

But we are not yet through with this wonderful advance, for we find that the product is not allowed to cool from the time it enters the blast

furnace, in the form of ore, until it ends in the finished product, which is produced much faster, and with much less expense than in the early days. But now comes the important question, what is it that has caused this great transformation in manufacture and cheapness of product. We can answer in the words of J. Stevens Jeans (at present the editor and chief owner of the *Iron and Coal Trades Review*, of London), in his article on the supremacy of the iron market, published in the November number of the *Engineering Magazine*, page 199:

1. Abundance of cheap raw materials of good quality.
2. Favorable conditions for manufacturing near to shipping ports.
3. Cheap transport, by land and water, but especially by land.
4. Economical, but not necessarily nominally cheap, labor.
5. Efficient technical equipment.
6. Facilities for ready and economical distribution of products.

After discussing at some length the question of the production of ores, etc., he says in summing up the question:

"So far as labor is concerned, the achievements and the experience of the United States have completely upset the fallacy that highly paid work is necessarily dear. On the contrary, it has been made evident that nominally dear labor is the cheapest of all, if its efficiency be guaranteed by proper methods and appliances. There are no works, either at home or abroad, where ores, coal, pig iron and steel ingots, or steel girders, rails and beams, are being made at so low a labor cost per ton of product, as in the United States; and yet there is no iron making country in which the nominal wages paid to labor are so high."

Also as bearing more particularly upon the subject in hand, I quote again from the same article as follows:

"Efficient technical equipment has been spoken of as one of the essential elements in the success of manufacturing competition. Until a comparatively recent date, Great Britain stood unrivaled from this point of view, and was, indeed, *sui generis* as a manufacturing nation. But the economic policy adopted by the United States, and which is often supposed to cramp and fetter invention, did not hinder a band of brilliant engineers and metallurgists from exerting themselves to improve upon British methods and appliances, until they placed American practice far ahead of anything in Europe. It is hardly needed to multiply examples of this well-known fact, a part, by the way, seldom disputed now even by the most conservative of British manufacturers. American methods enable much larger yields to be obtained from a given plant, alike in iron works and in steel works, and generally at a lower labor cost. Fortunately for Great Britain, she has awakened to the importance of getting abreast of American practice, and is now endeavoring, although still, as a rule, at a more or less considerable distance, to approach or rival America's mechanical achievements."

As these statements are such as can easily be substantiated by facts, they become almost axioms to the mind of any observing person of today. While the iron trade has been steadily marching onward, we find the coal trade in many respects still plodding along in the old ruts of early days. True it is that there are many improvements in the way of operation which have been very instrumental in increasing the output of coal—such as the application of steam, electricity and compressed air, and automatic machinery to the economic handling of coal, all of which are, *per se*, excellent. Even with these we find ourselves confronted at some points by the question from one operator as to why his neighbor can sell coal for a certain price and make some profits, while the questioner, selling his for the same or even a little more, is not making any money. And allow me to say that it is only when it presents itself in this light—viz., the financial—that it is brought home to many mine owners.

The answer is simple. It is the difference between the saving of a few cents per ton and the spending of the same in the production of coal, leaving out of consideration the question of honest or dishonest practices. But the answer in detail is not so simple as it appears at first glance. There are many little expenditures which, to the unpracticed or uneducated person, seem to be necessities. These are easily discernable when they come on the outside in the way of transportation, etc., but when the trouble comes in the mine, as it frequently does, it is not so apparent. Consequently I will shorten this by saying that in the outstart of a mining operation a competent mining engineer should be employed to make a complete and exhaustive study of the proposed works, so that the openings can be located to the best advantage for the economical working of the coal, as to shipping, hauling, drainage, ventilation and the equipping of the mine with machinery and appliances, especially adapted to the case. This is one of the cases which is most prolific of good or bad results, for on the proper location and equipment largely depends the question whether a mine can be made to pay or not, and a few hundred dollars paid for engineering would pay such handsome returns, that if they were capable of exact comparison would certainly redound to the development along this line.

Another, a common practice among a number of mine owners is to have the engineering done either by themselves, the line foreman or the superintendent, or as in some cases, it is thrown upon the inspector of the district. Then, so as not to make themselves amenable to the State laws, they employ an engineer to do a little surveying for them, viz., to measure up their mines, and possibly if they are driving up to property lines have him set a few sights and give a few distances. This they term in general parlance engineering, while in reality it is only a little surveying. But it is a good makeshift for eluding the mining law and having some one on whom to place the blame, should anything go wrong. While this is the status of things in many of the mines, I do not wish to be understood as saying this is the condition in all of them, or even generally, for some of the more progressive have found out that it pays handsomely to employ an engineer to conduct the mining operations. In one case which I have in mind, in the Pittsburgh district, a firm which was getting 100,000 bushels per acre, and had averaged that for a good sized field, employed a mining engineer in fact as well as in name, with the result that the output was increased from 100,000 to 110,000 to 113,000 bushels per acre of 1¼-inch coal, and this without any extra cost in the way of equipment or cost of original coal.

This gain, after allowing for the mining and hauling and expense of handling, would amount to, say, 2 cents per bushel, which profit would aggregate more than the original cost of the coal. In this case a fair average year's work I would estimate at about 40 acres, which would in itself make a profit of from $10,000 to $12,000 per year, while the engineering for this would possibly not cost them more than $1,500 or $2,000 per year. But this item is not the only saving due to this method of operation, for we find that the mine is in better condition, and should any emergency arise, instead of the mine foreman having all of this to attend to, the engineer directs how it is to be taken care of, and much money, time and profanity is saved, while the mine foreman is left to take care of the duties which properly belong to him. The entries and rooms are all driven to line and kept straight, thus giving a far freer movement of air, a more uniform thickness of rib with its many attendant advantages. Then again the question as to the drainage of the mine, the removal of gases, etc., which are generally thrown upon the mine foreman should not be placed upon him. The plan for these things should be thought out carefully by the engineer, whose mind is free from the onerous routine duties of the mine foreman, and then the two in conjunction can devise means for carrying out these plans. If some such system as this were put into practice in all mines, I believe that not only the interests of the mine owners, but the State and country in general would be greatly benefitted by the saving to the coming generations much of the valuable coal which is now being buried never to be utilized so far as we know of.

On the Densities of Nitrogen, Oxygen and Argon, and on the Composition of Atmospheric Air.

By A. Leduc.

[Translated from *Comptes Rendus* by Chief Engineer Isherwood, U. S. Navy.]

As the discovery of argon has modified some numerical results concerning atomic weights, molecular volumes, and, chiefly, the density of nitrogen, which I have heretofore published, I have again been led to further experiment on some gases,[1] particularly oxygen, the density of which, according to my previous experiments, seemed to me to be a little too low, relatively to that of chemical nitrogen.

Nitrogen.—Lord Rayleigh, who had already determined the density of nitrogen prepared in different ways, has done me the honor of communicating in writing his experiments, the chief object of which was to ascertain whether the density of this gas were independent of the process of preparation. I propose to find, as exactly as possible, the density of nitrogen, prepared by the following processes that seem best adapted to furnish it in a state of purity:

1. Decomposition of the nitrite of ammonium by heat. The gas obtained contains considerable quantities of the oxides of nitrogen and of ammoniacal gas; it is purified by a long column of copper, followed by oxide of copper raised to incandescence.

2. Decomposition of the nitrate of ammonium by heat. The impure nitrogen protoxide thus obtained is treated as above.

1. Carried on in the Physical Laboratory of the Sorbonne.

3. Decomposition of nitric oxide by incandescent copper.

4. Decomposition of ammoniacal gas by incandescent oxide of copper; which oxide is followed by a column of copper that has for its object the decomposition of the oxides of nitrogen produced by the preceding reactions.

In all cases the nitrogen obtained traverses, before entering the weighing globe, a column of potassa and another of pumice stone saturated with H_2SO_4, and a U-tube charged with phosphoric anhydride.

A vacuum is made in all parts of the apparatus, previous to the operations, in order to prevent the presence of argon.

The weights of nitrogen, at 0° and 76 cm., contained in the globe, are comprised between 2 gr. 0.8467 and 2 gr. 0.8474; their mean, 2 gr. 0.8470, corresponds, all corrections made, to the density .96717[1] relatively to the density of air.

Oxygen.—I have previously found for the density of oxygen relatively to the density of air 1.10506. Although this number is the result of only a single series of experiments—electrolysis of a solution of potassa—I have accepted it without hesitation because it harmonizes with other results obtained up to the present time.

After the discovery of argon this number appeared to me to be a little too low, and I then prepared the oxygen by decomposing by heat the crystallized permanganate of potassa. Before entering the weighing globe, the gas passed over potassa, acidified pumice and sulphuric anhydride. The density was found to be near 1.10527.

I now prepared the oxygen by electrolysis, but instead of a short column of spongy platinum, I employed for eliminating the hydrogen a long column of oxide of copper at a dull red heat. Three very concordant experiments gave 1.10521.

Convinced by these latter experiments of the insufficiency of the spongy platinum in the preceding ones, I accept for the density of oxygen 1.10523.

Argon.—I have many times had occasion to remark that the close concordance of the numbers obtained by Lord Rayleigh and by myself for the density of atmospheric nitrogen implied the constancy of the proportion of argon in the atmosphere. This point has recently been put beyond doubt by Mr. Schloesing, Jr.,[2] who has found the proportion of argon in atmospheric nitrogen to be 0.0119.

Designate by d, d' and x, the densities of chemical nitrogen, atmospheric nitrogen and argon.

$$\text{We have } (d' = 0.97203).$$
$$d' = 0.0119\,x + (1-0.0119)\,d.$$
$$\text{Whence results } x = 1.376.$$

Or, relatively to hydrogen, 19.80, instead of 19.9, heretofore accepted.

Résumé.—It will be useful to fix these results by giving the weight of a liter of each of these gases at 0°, both under the pressure of a bayre (10^6 C. G. S.) and under the normal pressure of the atmosphere at Paris, as follows:

Pressure.	Oxygen.	Nitrogen.	Argon.
1 Barye	1 gr. 4,100	1 gr. 2,338	1 gr. 755
1 Atmosphere.....	1 gr. 4,293	1 gr. 2,507	1 gr. 780

I shall return hereafter to the atomic weights of nitrogen and oxygen.

Composition of Atmospheric Air.—I have a great many times determined the composition of dry atmospheric air deprived of carbonic acid, etc., and have found that it contained in mean $\frac{209}{1000}$ of its weight of oxygen.

The consideration of the densities of oxygen and atmospheric nitrogen[3] leads to the number 232.08, which can be taken as identical with the preceding.

On the other hand, the $\frac{768}{1000}$ of atmospheric nitrogen divides proportionally to the numbers 9,881 × 0.96717 and 119 × 1.376, which gives $\frac{755}{1000}$ for the nitrogen and $\frac{13}{1000}$ for the argon.

The centesimal composition of mean atmospheric air is consequently represented by the following table:

	Nitrogen.	Oxygen.	Argon.
By weight.....	75.5	23.2	1.3
By volume.....	78.06	21.0	0.94

1. As I have remarked in previous publications, the last decimal may have an error of several units. Further, as the present number has much probability of being too great, it can, with prudence, be reduced to 0.9671.

2. *Comptes Rendus*, November 2, 1896.

3. A. Leduc. *Comptes Rendus*, August 4, 1890. The employment of the number 1.10506 for the density of oxygen led me, at that time, to 232.35. The difference seems to me to be due to experimental error.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE authorities of Painesville, Ohio, are considering the matter of establishing a gas works, for operation on municipal account.

MESSRS. FRED HARVEY, John Wilson, James A. McGonigle, Jas. L. Abernathy and D. R. Anthony, Jr., are said to be the incorporators of the proposed opposition company for Leavenworth, Kansas. Their slogan is, "Dollar gas," which looks a pretty small figure for the place named.

THE Milwaukee (Wis.) Gas Company, has subscribed the sum of $1,000 towards defraying the expenses of the Milwaukee Carnival, to be held next June.

THE Newark (N. J.) Gas Company has notified its patrons in the Harrison, Kearny and East Newark districts that the gas rate hereafter will rule at $1.40 per 1,000 cubic feet—a concession of 20 cents per 1,000.

LAST week we said that "Mr. Peter C. Young, who has been in charge of the Knoxville (Tenn.) Gas Light Company's works, since 1889, has been named as Manager" of the Peoples Gas Light and Coke Company, of Buffalo, N.Y. The statement was in error, for it was Mr. Peter Young, recently in charge of the Peoples Heat and Light Company, Limited, of Halifax, N. S., who was chosen Manager of the Buffalo opposition company. Further, we understand that Mr. Robert Young is the Superintendent of the Knoxville plant.

AT the annual meeting of the Consumers Gas Company, of Woodbury, N. J., the officers chosen were: President, Dr. H. C. Clark; Vice-President, Colonel George G. Green; Secretary and Treasurer, C. N. Starr; Superintendent, George W. Curtis.

MR. A. D. MEEDS, official gas inspector for Minneapolis, Minn., reports that during the year ended December 31, 1897, the lighting, etc., of the city streets, cost $170,000. The total length of lighted streets in Minneapolis is 236.21 miles, of which 82.24 miles are lighted by means of gasoline lamps; 81.97 are lighted by gas lamps; and the balance by arc lamps. The outside deductions from the lighting bills for the year were: Electric lights, $1,420.22; gas lamps, $6.91; gasoline, $119.41. The average candle power of the gas supplied on city account for the year was $25.15; maximum power, 29.97 candles, in September; minimum, 19.36 candles, in June. The average consumption of gas in the street lamps per burner per hour, was 6.11 cubic feet. The ordinance directs that each burner shall consume not less than 6 cubic feet per hour.

IT would seem that the troubles of the old Middletown (Ohio) Gas Company have been straightened out, for those interested in its former fortunes, with copartners in the shape of other capitalists, have incorporated the Middletown Gas and Electric Light Company. The declaration is that the Company will engage in the manufacture and production of artificial and natural gas and the sale thereof for lighting purposes; also, the production and sale of electricity for power and lighting purposes. The named incorporators are: Charles E. Denny, W. F. Simpson, W. A. Barnitz, T. E. Reed and J. J. Gallagher.

THE reduction in the gas rate (it is now $1.75 per 1,000 cubic feet) of Newburyport, Mass., has had the usual effect of increasing materially the Company's output.

THE proprietors of the Ipswich (Mass.) Gas Light Company have reduced the selling rate to $2.25 per 1,000 cubic feet.

MR. IRVIN BUTTERWORTH, General Manager of the Columbus (Ohio) Gas Company, writing under date of the 6th inst., says:

To the Editors AMERICAN GAS LIGHT JOURNAL: Referring to your editorial, "Is the Saving Worth the Difference?" in the JOURNAL of the 3d inst., and the letter of "Veritas" in the same number, I would venture to express the following opinions: First, that, notwithstanding the popular impression to the contrary, the percentage of gas consumers who really and honestly doubt the accuracy of modern gas meters is very small indeed; second, that the percentage who suspect the gas companies of purposely causing meters to register against the consumers is very much smaller; third, that the confidence of such suspecting consumers would in no wise be "restored," if told that gas companies do not repair their own meters. Gas consumers, as a class, do not know how gas meters are kept in repair; and, therefore, the question as to who makes the repairs does not enter into their suspicions. Any community that would suspect its gas company of "doctoring" its meters

would just as readily suspect it of having an 'understanding' with an outside meter repairing concern. A good plan is never to test a meter for a suspecting consumer without first inviting him to be present and witness the test, assuring him it is so simple that he would readily understand it and be satisfied as to its conclusiveness.

THE JOURNAL for November 29 contained an accurate statement respecting the trouble which was occasioned, in Mount Vernon, N.Y., on the night of November 19 through the passage of some unpurified gas to the consumers' burners, the gas having been supplied by the East Chester Gas Company. Our readers perhaps will remember that one or more New York newspapers contained sensational accounts of the happenings, and it is evident that some of their exchanges "in foreign parts" fully (and more) believed that the *Journal* and the *Herald* even in their exaggerated sensational reports of the affair, did not tell the whole truth. In support of this belief, we submit the following report of the happening, which report was printed in the Stockholm (Sweden *Tidings*, dated December 20, 1897—the article was translated by the Rev. John Hillberg, Pastor of the Swedish Methodist Church, Mount Vernon, N.Y.: "The city of Mount Vernon, in North America, has in three days experienced a singular accident. In the little city, of about 22,000 population, 15,000 persons were poisoned by gas. In almost every house people laid overcome; others were seen rushing out of the houses, trembling and falling. Some have lost the ability of speech; others are blind; 24 persons have become insane. The poison it is thought has come through unburnt gases, filled with sulphur and ammonia. The smoke of this gas has been inhaled by 80 per cent. of the population, and, happily to say, only 4 died. But through many days the inhabitants of the little city have walked about with insunken eyes, pale and weak; the doctors have been very busy and were compelled to telegraph to New York for help. The Director of the gas works declared that there was nothing at fault with his apparatus, but a search proved the contrary. As a result, the sick men in a thorough American manner, gave the Director a substantial lashing and drove him out of town."

MR. CHARLES H. JACOBS, who has been active in the business of the Buhl Stamping Company for some time, writing from Detroit, Mich., under date of the 4th inst., says that "The meter business established by the Buhl Stamping Company in 1894 will be conducted hereafter by a separate corporation, known as the Detroit Meter Company." The officers of the Company are: President, Mr. Theodore D. Buhl; Secretary and Treasurer, Charles H. Jacobs. The headquarters of the Company are on the site bounded by Third and Fourth streets and Congress and Larned streets, Detroit.

DURING the year 1897 orders for the Cabot gas trays were received from 77 separate gas companies in the United States and Canada. Mr. Cabot also advances the idea that the outlook for the current year is excellent, judging from the number of inquiries so far received.

PRESIDENT WRIGHT, Secretary Templeton and Superintendent Stone, of the Ashtabula (O.) Gas Company, are in high feather over the results that have attended and are attending their control and conduct of the plant. That they have ample cause for congratulation is strikingly borne out by the following concise statement: Number consumers' meters in place January 1, 1896, 237; output for year ended January 1, 1896, 5,000,000 cubic feet; number consumers' meters January 1, 1897, 369; output for year ended January 1, 1897, 9,000,000 cubic feet; number consumers' meters January 1, 1898, 503; output for year ended January 1, 1898, 13,000,000 cubic feet; increase in number of consumers in two years, 112 per cent.; increase in output in two years, 160 per cent. They have good reason to be satisfied with what they have done, and they further have just as good cause for belief that that which is to come will be quite like that which had been received.

MR. G. D. AIKEN, Superintendent of Construction of the Salt Lake and Ogden (Utah) Gas and Electric Light Company, resigned that position to accept an important place in the service of the Western Union Telegraph Company. His fellow workmen in the Salt Lake and Ogden Company, as a token of how they regarded him, just before he "put off the old job to take on the new," presented him with a handsome watch chain and charm.

MESSRS. Jas. B. Miller and A. B. Melville, who are said to hail from Chicago, have, through Mr. C. M. Harrison, applied for a franchise to operate an opposition gas works in Sioux Falls, South Dakota. Our information about the concern is to the effect that its projectors are those interested in the revamping of the Hall process. What the Hall process really needs, in our estimation, is a set of uppers, for the original ones have been welted out of sight in every Eastern gas community that knew enough to keep its feet dry.

AT the annual meeting of the Girardville (Pa.) Gas Company the officers chosen were: President, Albert Bordy; Vice-President, James Brady, Sr.; Secretary, Thomas L Evans; Treasurer, E. K. Becker; Superintendent, Nicholas Blass.

AT the annual meeting of the New Haven (Conn.) Gas Light Company the Directors chosen were: Charles R. Ingersoll, George J. Brush, Francis Wayland, Andrew W. Deforest E. H. Trowbridge, Pierce N. Welch, George D. Watrous, Robert A. Brown and T. A. Barnes.

DURING the year 1897 the output of the Excelsior Coke and Gas Company, of Topeka, Kansas, was well in excess of 32,000,000 cubic feet.

THE prospect is that the arbitrators (Messrs. A. H. Johnson, of Oberlin, Ohio, and F. L. Slocum, of Pittsburgh, Pa.) to value the plants of the gas and electric interests of Lorain, Ohio, preparatory to consolidation of both, have named a figure which will result in a satisfactory solution of the problem presented.

IT may not be news to many of our readers to say that Mr. Charles G. Dawes, who succeeded Mr. James H. Eckels as Comptroller of the Currency, was quite prominent in the gas business, having been at various periods in his career connected with the Companies in Evanston, Ills., LaCrosse, Wis., and Akron, Ohio.

EXCERPTS from the report of the Superintendent (Mr. W. P. Knowles) of the Richmond (Va.) City Gas Works, for the year ended December 31, 1897, are to this effect:

Month.	Gas Made, Cu. Ft.	Gas Used, Cu. Ft.
January	25,781,900	25,682,840
February	20,799,500	20,755,492
March	20,183,300	20,172,449
April	15,905,300	15,921,567
May	14,493,700	14,486,678
June	12,123,300	12,213,967
July	11,446,700	11,217,836
August	12,350,600	12,414,720
September	13,614,800	13,568,416
October	18,961,800	18,958,771
November	21,223,800	21,352,493
December	25,862,000	25,811,858
Total	212,746,700	212,557,087

The weight of coal used was 7,850 tons; of coke, 4,135 tons; of oil, 619,866 gallons. Meters to the number of 233 were placed for new consumers; total number of meters in use, 6,737. The main system was added to by the putting down of 1¼ miles of pipe, bringing the total mileage up 74¼.

MR. GILBERT DARLING, a member of the Board of Directors of the Woonsocket (R. I.) Gas Company, died at his home in Providence, R. I., on the morning of the 2d inst. Deceased who was born in Bellingham, Mass., Jan. 21, 1818, was a brother of the Hon. L. M. Darling, President of the Pawtucket (R. I.) Gas Company.

PRESS despatches to the Detroit (Mich.) newspapers, dated the 7th inst., are to the effect that the Government of Canada, after careful investigation, has decided upon its policy regarding the pumping of Canadian natural gas to the United States. The Companies now pumping gas across the Detroit river are not to extend operations further than they have already gone. In addition the Government has seen fit to order the charter of the Interior Construction Company to be canceled. This is the concern which put down the pipe line across the river at Detroit, and which would like to extend its operations. Under the terms of its incorporation in 1895 in was to pay a rental (nominal) of $10 per year for the privilege, and this it failed to do. The probabilities are, therefore—so the despatches read—that the industry will be kept within reasonable bounds, especially as the report states distinctly that the supply is limited.

THE authorities of Dover, N. H., have authorized the United Gas and Electric Company to maintain during the next five years on public account 130 or more electric arcs, at a price not to exceed $67 per lamp per annum. The candle power is not to be lower than 1,200, and the table of lighting time directs that the lamps shall be lighted from dusk until midnight of each 24 hours, "except on such moonlight nights as lights are not required." It is further stipulated that the option is reserved by the city "of running not less than 40 of such lamps all night at any time during the continuance of the contract at an added annual cost per light of $20."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

MONDAY, JANUARY 17, 1898.

An Isolated Plant Driven by Gas Engines.

According to the *Electrical World*, an isolated electric lighting plant, interesting because of the fact that gas engines are used as the prime movers, without storage batteries or any particular attempt to secure uniformity of loads, is described in a recent number of the London *Electrician*, from which the following points are abstracted :

The station is one of those erected by the Midland Railway Company for the lighting of its termini in large cities. The use of gas power instead of steam in this particular station at Leicester was caused by the lack of available space for a steam plant at or near the site best adapted for a distribution center. The gas generating machinery consists of two Dowson gas generators, each capable of generating from coke sufficient gas for 100-brake horse power, or from anthracite for 120-horse power. There are two small boilers, each capable of supplying sufficient steam for the operation of both these generators. For each generator a cooler, hydraulic box, coke scrubber and sawdust scrubber are provided. The gasholder has a capacity of about 2,000 cubic feet.

The power-generating room is equipped with a number of Crossley gas engines, belted to direct-current dynamos, for arc and incandescent lighting. Four of the engines have a stroke of 21 inches, with a cylinder diameter of 16 inches, and are capable of developing 90-horse power at 200 revolutions per minute. Two smaller engines are provided, capable of developing 50-horse power at the same speed. All these engines are horizontal trunk piston Otto cycle engines, with valves of the mushroom type, and heated tube ignition. Figures of available power are given for use with coal gas, of which there is a reserve supply kept for emergency use. With Dowson gas the engines give about 20 per cent. less power.

Three of the larger engines drive three 60-light 10 ampere Brush arc machines, the fourth driving a Mordey Victoria 110-volt direct current dynamo. Two smaller 100-volt machines are also belted to the two smaller gas engines. The several loads on the various dynamos and engines are all independent, and subject to considerable variations, the loads on the various high and low-tension machines being comparable for irregularity and trying conditions with those of ordinary steam-driven stations. The variation in load comes back even to the gas generators, as the capacity of the gasholder is only sufficient to run the whole load for about ten minutes. In spite of this, no trouble has been experienced with regulation.

Repairs on this apparatus have not been by any means serious. The engines are carefully overhauled after each run, or, when the lighting is necessarily continuous day and night, as during the time of fogs, they are overhauled when an opportunity can be found. All valves are cleaned once a week the year round, and if necessary are freshly ground. The exhaust valves are turned up every 12 months and the air valves every two years. The coke in the scrubbers is renewed every six months and burned in the boilers. The sawdust in the scrubbers is renewed about every 100 hours of working, at an expense of about 60 cents a scrubber. The generator fires are cleaned every 24 hours. About 9 per cent. of the weight of the total fuel burned is used in the small vertical boilers employed in raising steam for the air injectors of the generators. The gas generators are found to work equally well over a wide range of weight of production. From full load to one fifth load, the gas produced is found to range practically of the same quality, giving about 40 calories per cubic foot.

Six other lighting stations, owned by the Midland Railway Company, are all driven by steam power, and the statistics of the expense of working show that the cost per kw. hour is practically the same in the gas-driven station as in the steam stations of about the same size.

The Market for Gas Securities.

The Equitable-New York-East River rearrangement of the terms of their merger with the New Amsterdam Company has been to every intent accepted by all the contracting parties, and that the deal will go through is a certainty. The award on acetylene account, although actually small, is altogether too large on intrinsic value account. If holders of Consolidated gas cannot read (between these preliminary skirmishings) accurately as to the value of their property, guardians should be named to help them figure out the worth of the stock. In our opinion the high notch of September last is likely to be surpassed ; and before the Legislature *adjourns*, at that. Consolidated opened to-day (Friday) at 181¼ to 181½, and closed at 179 to 181. The market for it has been very inactive during the last few days. Other city shares are dull and steady.

Brooklyn gas is in some demand, at firmer prices, the rate to-day being 121½ to 122. Lacledes are strong, at 47¼ to 47½, for the common, and the bonds are 113 to 114. Peoples, of Chicago, is maintained at the good figures for it of the last two months. Consolidated, of Balti more, is steadily advancing, and to us it seems cheap at current rates.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

JANUARY 17.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$36,230,000	100	181¼	181⅛
Central	500,000	50	..	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	260	262
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	285	310
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
Northern	150,000	50	..	
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	70	71
Preferred	2,000,000	100	98	104
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	105	106¼
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	185	187
Preferred	5,000,000	100	151	153
Bonds, 1st Mortgage, 5's	1,500,000	1,000	114	115
Yonkers	299,650	50	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	121¼	122
" " Bonds (5's)	15 000,000	1,000	113¾	114
Bay State	50,000,000	50	3¾	4
" Income Bonds	2,000,000	1,000	..	75
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	96¼	97
2d " " "	3,000,000	1,000	..	83
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Company	25,000,000	100	97¼	97⅜
Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Columbus	1,000,000	.	91	94
1st Mortgage	1,085,000	..	..	96
Consumers. Jersey City	2,000,000	100	77	..
" Bonds	600,000	1,000	102	105
Cincinnati G. & C. Co.	8,500,000	100	203	204
Consumers, Toronto	1,800,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	56¼	57
Mortgage, 6's	3,800,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit	4,000,000	.	55	57
" Con. Bonds	4,312,000	..	97	97¼
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	81	93
" Bonds	2,000,000	..	93	95
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	118	125
" Bonds, 6's	2 650,000	..	107	109
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	86	88
Bonds	1,000,000	1,000	93	94
Louisville	2,570,000	50	..	..
Laclede, St. Louis	7,500,000	100	47¼	47½
Preferred	2,500,000	100	92	93
Bonds	9,084,400	1,000	103⅝	104
Montreal, Canada	2,000,000	100	200	
Newark, N. J., Gas Co.	1,000,000	..	200	220
Bonds, 6's	4,000,000	..	124	130x
New Haven	1,000,000	25	225	
Oakland, Cal.	2,000,000	..	53¾	54
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	96¾	97
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	.	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	83	..
Consolidated 5's	2,000,000	..	87¾	90
San Francisco, Cal.	10.000,000	100	94	94¼
St. Paul Gas Light Co.	1,500,000	100	49	51
1st Mortgage 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	.	88	90
Syracuse, N. Y.	2,500,000	25	19¾	20½
Bonds	1,000 000		94	97
Washington, D. C	2,000,000	20	250	
Western, Milwaukee	4,000,000	100	82	85
Bonds, 5's	3,556,000	.	102	103
Wilmington, Del.	550,000	50	200	

Advertisers' Index.

GAS ENGINEERS.

	Page
Wm. Henry White, New York City	115
Fred. Bredel, Milwaukee, Wis.	100
Geo. R. Rowland, New York City	115
The Western Gas Construction Co., Fort Wayne, Ind.	102
Humphreys & Glasgow, New York City	106
American Gas Co., Phila., Pa.	100
David Leavitt Hough, New York City	117
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	115

PROCESSES.

	Page
Bartlett, Hayward & Co., Baltimore, Md.	113
United Gas Improvement Co., Phila., Pa.	105
Burdett Loomis, Hartford, Conn.	114
National Gas and Water Co., Chicago, Ills.	107
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	115
The Western Gas Construction Co., Fort Wayne, Ind.	102
Humphreys & Glasgow, New York City	106

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd's Sons, New York City..... 116
Continental Iron Works, Brooklyn, N. Y..... 114
Deily & Fowler, Phila., Pa..... 116
Kerr Murray Mfg. Co., Fort Wayne, Ind 112
Stacey Mfg. Co., Cincinnati, Ohio..... 115
Bartlett, Hayward & Co., Baltimore, Md..... 113
Davis and Farnum Mfg. Co., Waltham, Mass..... 112
R. D. Wood & Co., Phila., Pa..... 114
Isbell-Porter Company, New York City..... 114
Fred. Bredel, Milwaukee, Wis..... 100
United Gas Improvement Co., Phila., Pa..... 105
Berlin Iron Bridge Co., East Berlin, Conn..... 97
National Gas and Water Co., Chicago, Ills..... 108
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 115
The Western Gas Construction Co., Fort Wayne, Ind.... 112
Humphreys & Glasgow, New York City..... 106
Gas Engineering Co., Pittsburgh, Pa..... 112
American Gas Co., Phila., Pa..... 100
Logan Iron Works, Brooklyn, N. Y..... 116
Riter-Conley Co., Pittsburgh, Pa..... 99

SCRUBBERS AND CONDENSERS.

G. Shepard Page's Sons, New York City..... 115
R. D. Wood & Co., Phila., Pa..... 114
James R. Floyd's Sons, New York City..... 116
Continental Iron Works, Brooklyn, N. Y..... 114
Gas Engineering Co., Pittsburgh, Pa..... 112
Logan Iron Works, Brooklyn, N. Y..... 116
Riter-Conley Co., Pittsburgh, Pa..... 99
Kirkham, Hulett & Chandler, London, Eng..... 90

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md..... 113
Fred. Bredel, Milwaukee, Wis..... 100
J. H. Gautier & Co., Jersey City, N. J..... 110
Parker-Russell Mining and Mfg. Co., St. Louis, Mo..... 110
Adam Weber New York City 110

TAR AND CARBONIC ACID EXTRACTOR.

G. Shepard Page's Sons, New York City..... 115
R. D. Wood & Co., Phila., Pa..... 114

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich..... 97
G. Shepard Page's Sons, New York City..... 115
Gas Engineering Co., Pittsburgh, Pa..... 112

GAS METERS.

John J. Griffin & Co., Phila., Pa..... 80
American Meter Co., New York and Philadelphia..... 119
Helme & McIlhenny, Phila., Pa. 119
D. McDonald & Co., Albany, N.Y..... 117
Nathaniel Tufts, Boston, Mass..... 118
Maryland Meter and Mfg. Co., Baltimore, Md..... 118
Metric Metal Co., Erie, Pa 118
Keystone Meter Co., Royersford, Pa..... 118
Buhl Stamping Company, Detroit, Mich..... 119

PREPAYMENT METERS.

American Meter Co.. New York and Philadelphia..... 119
John J. Griffin & Co., Phila., Pa..... 80
D. McDonald & Co., Albany, N. Y..... 117
Helme & McIlhenny, Phila., Pa..... 119

GAS AND WATER PIPES.

Ohio Pipe Co., Columbus, Ohio..... 117
M. J. Drummond, New York City..... 117
R. D. Wood & Co., Phila., Pa..... 114
Warren Foundry and Machine Co., New York City..... 117
Donaldson Iron Co., Emaus, Pa..... 117

PIPE CUTTERS.

The Anderson Pipe Cutter Co., Marlboro, Mass..... 98

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, Brooklyn, N. Y..... 107

GAS COALS.

Penn Gas Coal Co., Phila., Pa..... 109
Perkins & Co., New York City 108
Despard Gas Coal Co., Baltimore, Md..... 109
Westmoreland Coal Co., Phila., Pa..... 109
Berwind-White Coal Mining Co., New York and Phila... 108
W. D. Althouse & Co., Phila., Pa..... 109

CANNEL COALS.

Perkins & Co., New York City 108
W. D. Althouse & Co., Phila., Pa..... 109

GAS ENRICHERS.

Standard Oil Co., New York City 109
The Sun Oil Co. Pittsburgh, Pa..... 109

COKE CRUSHER.

C. M. Keller, Columbus, Ind..... 109

CONVEYING MACHINERY.

C. W. Hunt Company, N. Y. City 97

GAS GAUGES.

The Bristol Co., Waterbury, Conn..... 99

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City 107
Isbell-Porter Co., New York City..... 114
The Wilder Mfg. Co., Phila., Pa..... 99
R. D. Wood & Co., Phila., Pa..... 114
Wm. M. Crane & Co., New York City..... 98

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Co., New York City..... 114
Continental Iron Works, Brooklyn, N.Y..... 114
G. Shepard Page's Sons, New York City..... 115
Logan Iron Works, Brooklyn, N. Y..... 116
R. D. Wood & Co., Phila., Pa..... 114

CEMENTS.

C. L. Gerould & Co., Mount Vernon, N.Y..... 110

RETORTS AND FIREBRICKS.

J. H. Gautier & Co., Jersey City, N. J..... 110
B. Kreischer & Sons, New York City..... 110
Adam Weber, New York City..... 110
Laclede Firebrick Mfg. Co., St. Louis, Mo..... 110
Cyrus Borgner, Phila., Pa..... 110
James Gardner, Jr., Pittsburgh, Pa..... 110
Henry Maurer & Son, New York City..... 110
Baltimore Retort and Firebrick Co., Baltimore, Md..... 110
Parker-Russell Mining and Mfg. Co., St. Louis, Mo..... 110
Brooklyn Firebrick Works, Brooklyn, N. Y..... 110
F. Behrend, New York City..... 98

INCANDESCENT GAS LAMPS.

Welsbach Commercial Co., Phila., Pa..... 104

THORIUM.

Dr. Philipp Hirsch, Berlin, Germany..... 97

INCANDESCENT LIGHT PREPARATIONS.

Dr. Philipp Hirsch, Berlin, Germany..... 97

MICA GOODS.

The Mica Mfg. Co., New York City..... 97

BURNERS.

C. A. Gefrorer, Phila., Pa..... 114
Wm. M. Crane & Co., New York City..... 98

LAVA GAS TIPS.

D. M. Steward Mfg. Co., Chattanooga, Tenn. 99

STREET LAMPS.

Welsbach Street Lighting Co., New York and Phila..... 98

PURIFYING MATERIALS.

Connelly Iron Sponge and Governor Co., New York City 107
Greenpoint Chemical Works, Brooklyn, N.Y..... 97
Henry W. Douglas, Ann Arbor, Mich 107
Gas Purification and Chemical Co., Ltd., London..... 107

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind..... 101
Isbell-Porter Company, New York City..... 114
Connelly Iron Sponge and Governor Co., New York City 107

VALVES.

Ludlow Valve Manufacturing Co., Troy, N. Y. 102
Chapman Valve Manufacturing Co., Boston, Mass..... 102
R. D. Wood & Co., Phila., Pa..... 114
Continental Iron Works, Brooklyn, N. Y..... 114
The P. H. & F. M. Roots Co., Connersville, Ind..... 101
Isbell-Porter Co., New York City..... 114
The Western Gas Construction Co., Fort Wayne Ind.... 102

ELECTRICAL APPARATUS.

Wm. Henry White, New York City 115

GAS ENGINES.

Otto Gas Engine Works, Phila., Pa..... 120
The American Gas Engine Co., Phila., Pa..... 111
Backus Water Motor Co., Newark, N. J..... 97

ENGINES AND BOILERS.

The Hazelton Boiler Company, New York City..... 97
W. G. & G. Greenfield, East Newark, N. J..... 97

PURIFIER SCREENS.

John Cabot, New York City..... 99

GAS STOVES.

American Meter Co., New York and Philadelphia..... 103
Maryland Meter and Manufacturing Co., Baltimore, Md. 118
Keystone Meter Co., Royersford, Pa..... 118
Wm. M. Crane & Co., New York City..... 98

GASHOLDER TANKS.

J. P. Whittier, Brooklyn, N. Y..... 106

GASHOLDERS.

Bartlett, Hayward & Co., Baltimore, Md..... 113
Continental Iron Works, Brooklyn, N. Y..... 114
Deily & Fowler, Philadelphia, Pa..... 116
Davis & Farnum Mfg. Co., Waltham, Mass..... 112
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 112
Stacey Mfg. Co., Cincinnati, Ohio..... 115
R. D. Wood & Co., Philadelphia, Pa..... 114
Logan Iron Works, Brooklyn, N. Y..... 116
Riter-Conley Co., Pittsburgh, Pa..... 99

GAS SECURITIES.

Marquand & Parmly, New York City..... 97

BOOKS, ETC.

Scientific Books..... 108
Field's Analysis..... 119
Digest of Gas Cases..... 109
Directory of Gas Companies..... 117
Practical Photometry..... 110
Coal Tar Genealogical Tree..... 106
Management of Small Gas Works 106
Handbook on Gas Engines 118
Gas Flow Computers 106
Hughes' "Gas Works"..... 107

WANTED,

Steady employment

By a Gas Meter Repairer and Prover,

where there is room for advancement. References given.

1180-1 Address "REPAIRER," care this Journal.

ENGAGEMENT DESIRED

By a Thoroughly Practical Gas Engineer and Manager.

Ten years' experience as Superintendent of Gas Works, Electric Plants and Water Works. Good references.

1180-2 Address "H. G.," care this Journal.

Position Wanted

As Superintendent of a Small Gas Works,

By a practical coal gas man. Is master of all details about the works, and in the laying of mains and services, gasfitting and general repairs. Best of references. Address

1179-2 "T. J.," care this Journal.

WANTED,

An Interest in a Gas Plant in the South.

In some healthy locality. Prefer town of from 5,000 to 15,000 inhabitants. Address

1180-1 "E. P.," care this Journal.

AN EXPERIENCED GAS ENGINEER AND CHEMIST

is open to accept immediate engagement; charge of works, or on the road. Experience in working inclined retorts. First-class references and testimonials. Address

1178 tf "M. R. S.," care this Journal.

VALUABLE GAS BUSINESS IN CALIFORNIA.

Concerning the best paying gas enterprises, covering two of the most rapidly growing cities in the United States, in which a valuable interest can now be secured, address for full information, T. S. C. LOWE,
223 South Spring St., Los Angeles, Cal.

Note.—This is our Spring season, and the time to build and improve gas works on this coast. (1176-tf)

Wanted, to Purchase or Lease,

A Gas Works in a Town of 5,000 to 10,000 Population, Near New York.

Or would buy a controlling interest. Particulars will be treated confidentially. Address

1172-3 "G. A. S.," care this Journal.

For Sale.

A Small Gas and Electric Light Plant,

in a Southern city of 3,800 inhabitants.

Address FORT WAYNE ELECTRIC CORPORATION,
1970-tf Fort Wayne, Ind.

FOR SALE.

Hydraulic, Dip, Branch and Ascension Pipes, Mouthpieces and Lids, for four Benches of 5's and for one Bench of 3 retorts.

Two Coolers, or Air Condensers, each of 150'000 cubic feet capacity.

Multitubular Condenser, shell, 36 in. diameter, with 98 2-in. tubes, 10 ft. 6 in. long.

D-Shaped Tar Extractor, 8 ft. long, 1 ft. 6 in. deep.

Scrubber, 48 in. diameter, 11 ft. 9 in. high. Three man holes, 11 in. by 15 in.

8-inch Center Seal. Four Purifiers, 8 ft. x 6 ft.

KEY CITY GAS CO
1119-tf Dubuque, Iowa.

FOR SALE,

at a bargain,

Two 50-H P. Otto Gas Engines,

in first-class condition.

Address WOONSOCKET GAS CO.,
1175-tf Woonsocket, R. I.

Utilize Your Gas Liquor.

NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator.

Not Expensive. Write to

STROH & OSIUS, Pat'ees, or
Mich. Ammonia Works, Detroit, Mich.

BRIDGES BERLIN BUILDING

OUR CATALOGUE

OF THREE HUNDRED PAGES ILLUSTRATING AND DESCRIBING A LARGE NUMBER OF

BRIDGES
BUILDINGS
AND ROOFS

Designed and Built by us

Is now ready and will be sent on application.

THE BERLIN IRON BRIDGE CO.
EAST BERLIN, CONN.

HIGH-PRESSURE WATER-TUBE BOILERS

EQUIPPED WITH

SQUARE FURNACE, SQUARE GRATE SURFACE, STEEL JACKET, LINED WITH BRICK.

Single Boilers or Compact Batteries.

GREAT SAVING OF FUEL AND FLOOR SPACE.
A HIGH-CLASS BOILER WITH AN UNEQUALED RECORD.

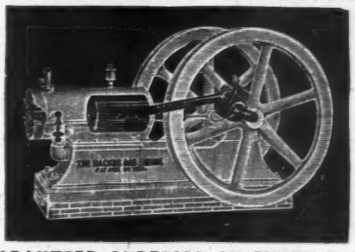
Send for our New Book, "The Generation of Power."

The HAZELTON BOILER COMPANY,

Sole Proprietors and Manufacturers,
Builders of Stacks, Tanks and Miscellaneous Metal Work.

Cable Address, "Palla," New York.
Tele., "1229—18th St," New York. **Gen'l Office, 716 E. 13th St., N.Y., U.S.A.**

BACKUS GAS ENGINES

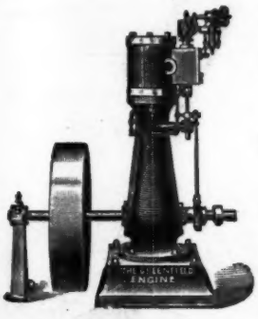


GUARANTEED SUPERIOR IN EVERY WAY. BUILT ON HONOR.

Agts. { **Chicago Water Motor & Fan Co.,** 101 Lake St., Chicago.
Michell & Co., - - 154 Congress Street, Boston, Mass

Home Office, **Backus Water Motor Co.,** Newark, N. J.

Send for Catalogue.



GREENFIELD
Steam Engine Works.

Established 1874.

MANUFACTURERS OF

Greenfield Stationary, Portable and Yacht

ENGINES AND BOILERS.

Also Horizontal, Automatic and Variable Cut-off Engines

Sizes from 3 to 75 Horse Power.

Also Vertical and Horizontal and Marine Boilers. Steam Pumps and Adams' Crate Bars.

W. G. & G. GREENFIELD, - · EAST NEWARK, N. J

MARQUAND & PARMLY,

160 Broadway, New York.

Members New York Stock Exchange.

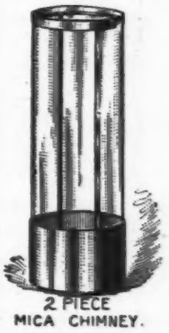
"RANGITOL" Ready Incandescent Light Preparation, in Powder Form or Liquid.

Furnished in Excellent Quality Cheaply.

DR. PHILIPP HIRSCH, Chemical Works, **PANKOW-BERLIN.**

NITRATE OF THORIUM, Chemically Pure, at the Cheapest Price. SAMPLES FREE IF DESIRED.

Our Mica Chimneys



2 PIECE MICA CHIMNEY.

Etched Chimneys to Order.

For Welsbach Lights

ARE THE

BEST IN THE WORLD.

Get Catalog and Discounts.

The MICA MFG. CO

Micasmiths,

88 Fulton Street, N. Y. City.

CHARGING CARS, to bring coal from storage bins to boiler room and retort houses.

No. 94122 Copyright, 1894, by C. W. Hunt Co.

COKE CARS, for handling hot coke directly from retorts.

TIP CARS, for carrying ashes, etc.

The difficulty of handling hot coke directly from the retorts led us to design a special car for this purpose, with an arrangement of piping which sends a spray of water over the entire surface of the sides and bottom, preventing the steel from becoming overheated when the hot coke is drawn into the car. This is not intended to entirely quench the coke, which is done in the usual manner, but to keep the iron from getting red hot, and, at the same time, to partially quench the coke.

We have just issued a new, 40-page, illustrated Catalogue, No. 9703, giving full description of our Industrial Railways. Before you forget it, send for a copy.

C. W. HUNT COMPANY,

No. 45 Broadway, - New York City.

IRON MASS

For Gas Purification.

Acts immediately, and more efficiently than any other purifying agent now in use.

GREENPOINT CHEMICAL WORKS,

Greenpoint Ave. and Newtown Creek, Brooklyn, N. Y.

BRAY'S BURNERS

WILL PLEASE YOUR CONSUMER BETTER THAN ANY OTHER BURNER YOU CAN BUY.

They are made by people who have had many years of experience, in the largest and best equipped Burner Factory in the world.

Every Burner is stamped with name and trade mark. Cheap and inferior imitations are constantly coming in and going out of use. This kind of deception causes loss and discredit to the trade and damage to the gas industry.

As Sole Agents in the United States for GEORGE BRAY & CO., we carry a full stock of all sizes for High and Low Pressures. Send for Prices and Special Pamphlet, or order a sample gross, stating your average house pressure.

SPECIAL BURNERS MADE FOR ACETYLENE GAS.

In ordering your supplies for the season put in a liberal stock of Bray Burners. It will pay; the best is always desirable and cheapest in the end. Our line of Brass Fittings is of superior make and finish, and the assortment covers everything for Gas Fixtures and Gas Stoves. Our "Vulcan" brand of Patent End Tubing for Gas Stoves and Drop Lights is guaranteed. The price is higher, but it is worth the price.

When you want a Catalogue covering the most complete line of Gas Appliances, send to us.

When you want any special apparatus made, for using Gas as Fuel, state particulars, and it will be our pleasure to correspond with you.

We want your trade, and can be of service to you.

WE MAKE GAS APPLIANCES EXCLUSIVELY.

WILLIAM M. CRANE & CO., Mfrs., Factory, 447 to 453 W. 14th St., Office, 838 Broadway. **NEW YORK CITY.**

THE ANDERSON Patent Cutter Carrying Link
Made in all sizes.

Will cut from 2 in. to 24 in.

Pipe Cutting Tool

For Cutting Cast, Wrought Iron, Gas & Water Pipes.

THE ANDERSON PIPE CUTTER COMPANY, Manufacturers, 293 Lincoln St., Marlboro, Mass
N. Y. Office, 135 Greenwich St
C. H. TUCKER, JR., Manager.
WALDO BROS., 102 Milk Street, Boston, Mass.

F. BEHREND,
SOLE IMPORTER OF THE CELEBRATED
German (Stettin-Didier) Clay Gas Retorts,
BLOCKS, TILES, FIREBRICKS, FIRE CEMENT,
Stettin "Anchor" & "Eagle" Brand Portland Cement
10 & 12 Old Slip, New York.

NEW YORK, 33 NASSAU ST. PHILADELPHIA, 245 N. BROAD ST. CHICAGO, 54 LAKE ST.

WELSBACH STREET LIGHTING COMPANY OF AMERICA,

——OWNS, CONTROLS AND OPERATES——
EXCLUSIVELY

STYLE No. 81.

THE NEW IMPROVED AND PATENTED STREET LIGHT BURNER.

STYLE No. 97.

Our PATENTED "STREET LIGHT APPLIANCES" have made WELSBACH STREET LIGHTING a complete success.

By the UNIFORM DISTRIBUTION of light on scientific principles a greater area can be lighted by our system and more economically than in any other way.

Where there are no gas mains already laid, we can furnish an equally good light by our **SELF-GENERATING NAPHTHA WELSBACH BURNER,** enabling Gas Companies to furnish a uniform light in all localities.

Our System is in practical use in many cities, among which we may mention

NEW YORK CITY.	WORCESTER, Mass.	PROSPECT PARK, BROOKLYN.
BALTIMORE.	CAMBRIDGE, "	EAST ORANGE, N. J.
ITHACA, N. Y.	BROOKLINE, "	NEW HAVEN, CONN.
COLLEGE POINT, N. Y.	FREEHOLD, N. J.	BEAVER, PA.

CORRESPONDENCE SOLICITED FROM GAS COMPANIES AND OTHERS INTERESTED IN MUNICIPAL LIGHTING.

THE Patent "Standard" Washer-Scrubber

(U. S. A. Patent, No. 486.927 of 29-11-'92.)

Order Recently Received—16 Machines, each for 3,500,000 Cubic Feet per day.

The Patentees of the above, after several years' experience, finding that the enormous weight of the iron sheets (forming the washing discs) caused undue wear of the shafts and consequent fractures of the latter, introduced their Patent Wooden "Grid Segments." These "segments" have now been fitted in some hundreds of Patent "Standard" Washer-Scrubbers, and are universally admitted to be a great improvement upon the out of date pattern.

The Patentees beg to refer Engineers to recent issues of the AMERICAN GAS LIGHT JOURNAL for testimonials as to the efficiency of their improvements and will be glad to quote for complete machines or for "grid segments" for fitting in old pattern Washer-Scrubbers, the manufacture to be English or American at enquirer's option. If for any *special reason* iron sheets are preferred, the Patentees will quote for them, but they do not recommend same.

KIRKHAM, HULETT & CHANDLER, Limited,

3 & 4 Palace Chambers, Bridge Street, Westminster, England.

Tel. Address: "WASHER, LONDON."

RITER-CONLEY COMPANY,

GASHOLDERS, with or without Steel Tanks.

Purifiers, Condensers, Scrubbers, Oil Tanks, Smoke Stacks.

STEEL ROOFS and BUILDINGS.

PLATE AND STRUCTURAL WORK OF EVERY DESCRIPTION.

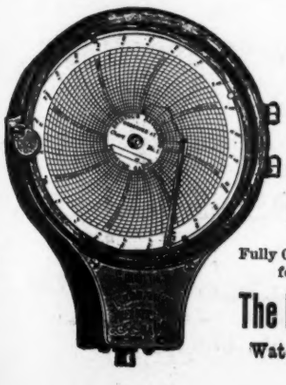
GENERAL OFFICE: Pittsburg, Pa. **EASTERN OFFICE: 39-41 Cortlandt St., New York City.**

THE GREATEST IMPROVEMENT IN GAS LIGHTING
Has been made by
WILDER'S VOLUMETRIC GOVERNORS.

They control the pressure at the burner, and deliver the quantity for which they are set regardless of high or low pressure in the supply.

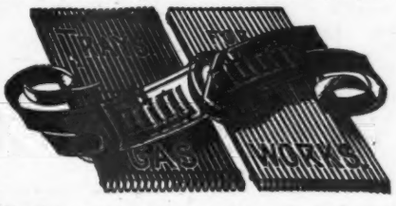
WELSBACH LIGHTS are fully controlled, and the governors soon pay for themselves by preventing the breaking of mantles and chimneys. Thousands are already in use. Orders may be given to the Welsbach Co., or sent to ourselves.

THE WILDER MANFG. CO., - - 818 Cherry St., PHILADELPHIA.



BRISTOL'S RECORDING
PRESSURE GAUGE.
For continuous records of **Street Gas Pressure**
Simple in Construction, Accurate in Operation Low in Price.
Fully Guaranteed. Send for Circulars.
The Bristol Co.,
Waterbury, Conn.

Special Trays for Iron Sponge or Oxide of Iron,
CHURCH'S TRAYS a Specialty.
Reversible, Strongest, Most Durable, Most Easily Repaired.



553-557 West Thirty-third Street, New York.
We also make the Cheapest and Strongest
REVERSIBLE BOLTED TRAYS IN THE MARKET.
Send for Circulars.

WRITE FOR PRICES.

WRITE FOR SAMPLES.

Investigate the Merits of
Steward's Special Union Jet Gas Burners.
They are the best Open Light Burners on earth.
THE D. M. STEWARD MFG. CO.,
CHATTANOOGA, TENN.

Practical Hints
ON THE CONSTRUCTION AND WORKING OF
Regenerator Furnaces,
By MAURICE GRAHAM, C.E.
Price, $1.25.
A. M. CALLENDER & CO., 32 Pine Street, N.Y.

AMERICAN GAS COMPANY

Constructors of Coal Gas Apparatus.

KLONNE-BREDEL

Recuperative Furnaces, Washers, Condensers, Purifiers and Purifying Machines, Ammonia Plant, Coke Conveyers, Etc.

Complete Works Erected with Guaranteed Results.

EASTERN AGENTS FOR

FRED. BREDEL'S SYSTEM
COAL GAS PLANTS AND GAS APPARATUS.

P. H. & F. M. ROOTS CO.'S
Exhausters, Blowers, etc.

222 South Third Street, Philadelphia, Pa.

GEORGE G. RAMSDELL, General Manager. Correspondence Solicited

FRED. BREDEL, C.E.

Coal and Water Gas Plants,

OWN SYSTEM.

Recuperative Furnaces, Washers, Condensers, Purifiers, Purifying Machines.

Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

COMPLETE GAS WORKS, COKE CONVEYERS, ETC.

No. 118 Farwell Avenue, · · Milwaukee, Wis.

Eastern Agents: AMERICAN GAS CO., Construction Department, 222 So. 3d St., Phila., Pa.

ROOTS'

LATEST IMPROVED GAS EXHAUSTER

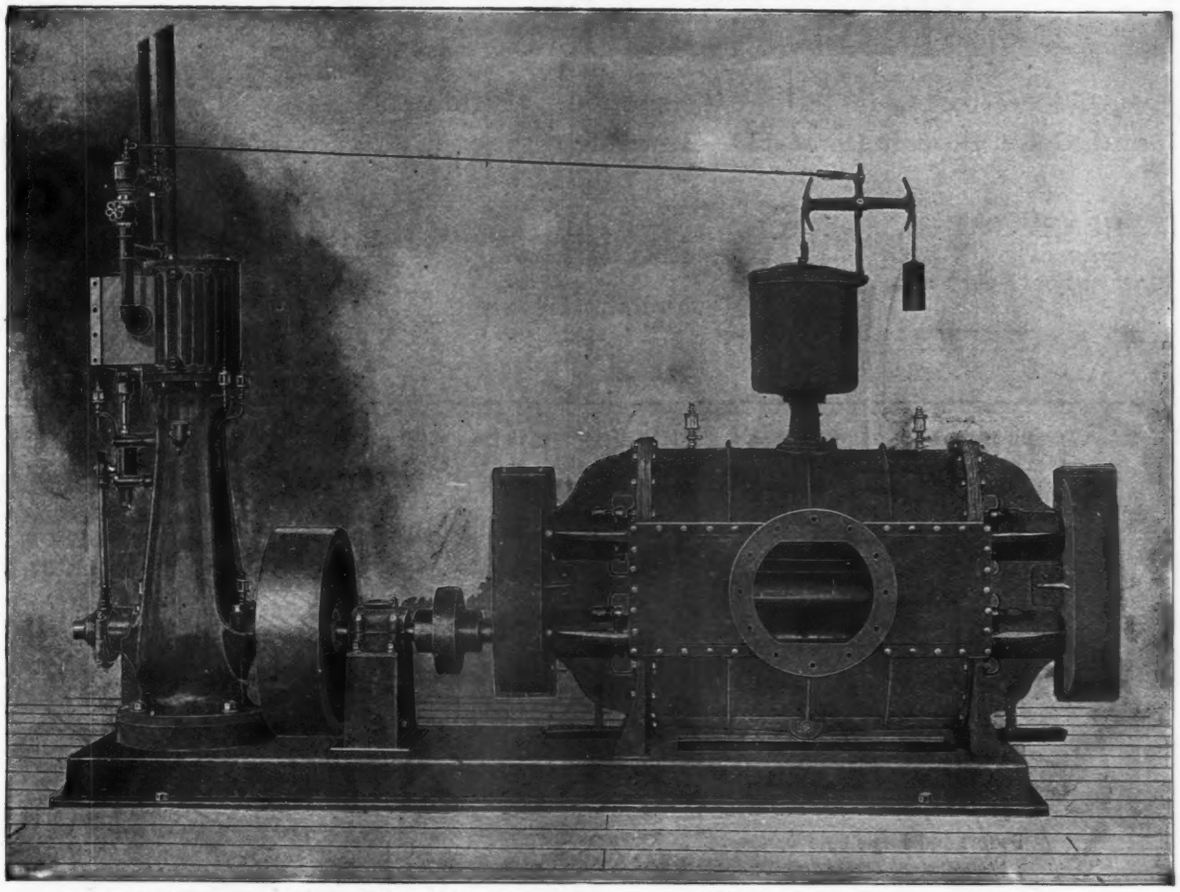
—AND—

NEW GAS GOVERNOR AND STEAM VALVE.

GUARANTEED TO REGULATE WITHIN ONE-TENTH OF AN INCH, WATER PRESSURE.

The Most Perfect Gas Governor on the Market.

MORE DIRECT IN ACTION. FEWER PARTS.
EASIER TO ADJUST THAN ANY OTHER GOVERNOR.



INQUIRIES CHEERFULLY ANSWERED. WRITE FOR CATALOGUE.

P. H. & F. M. ROOTS CO.

Connersville, Ind. 109 Liberty St., New York.

Eastern Office:

American Gas Company,

222 South Third Street, Philadelphia, Pa.

Because We Advertise

Improved Lowe Water Gas Apparatus so extensively do not infer that line to be our sole occupation. . . . .

BECAUSE WE BUILD

Coal Gas Works complete, Benches, Tar and Ammonia Apparatus, Condensers, Scrubbers, Purifiers, Valves, Center Seals, etc., etc., and

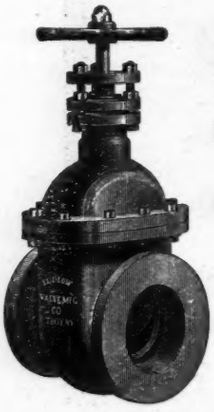
DESIGN AND CONTRACT

for Complete Plants, including Gasholders, Exhausters, Governors, Oil Tanks, Coal and Coke Storage and Handling Machinery, Steel Roofs and Buildings, etc.

WM. HENRY WHITE,
EASTERN AGENT,
32 Pine Street, New York.

The Western Gas Construction Co.,
Works and General Offices: FORT WAYNE, INDIANA.

CHAPMAN VALVE MANUFACTURING CO.,
MANUFACTURERS OF
Valves and Gates for Gas, Ammonia, Water, Etc.
Also, Gate Fire Hydrants with and without Independent Nozzle Valve. All Work Guaranteed.
Works & Gen'l Office, Indian Orchard, Mass. Treasurer's Office, 72 Kilby & 112 Milk Sts., Boston, Mass.
Chicago Office, 24 West Lake St. New York Office, 28 Platt St.
St. Louis Office, L. M. Rumsey Mfg. Co., 810 North Second St.



THE
Ludlow Valve Mfg. Co.,
TROY, N. Y., U. S. A.
Double and Single Gate Valves, ¼" to 72
—FOR—
Gas, Water, Steam, Oil, Ammonia, Etc.
HOT GAS VALVES A SPECIALTY.
Send for Catalogue.

GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE
Plans prepared and Estimates furnished at short notice.
J. P. WHITTIER,
70 Rush St. Near Division Ave., Brooklyn, N. Y.

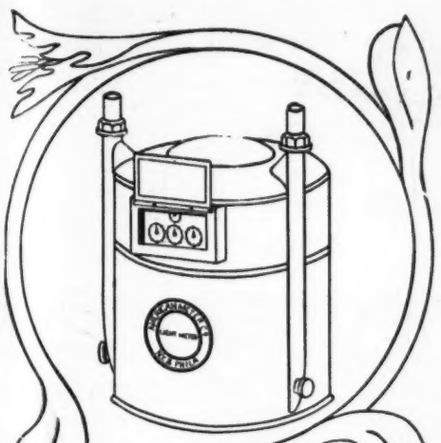
The Gas Engineer's Laboratory Handbook.
By JOHN HORNBY, F.I.C.
Price, $2.50.
A. M. CALLENDER & CO., 32 Pine Street, N.Y. City

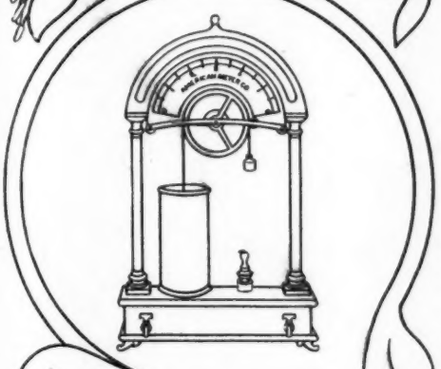
Practical Photometry.
A GUIDE TO THE STUDY OF THE MEASUREMENT OF LIGHT.
By William Joseph Dibdin.
Price, $3.00.
A. M. CALLENDER & CO.,
32 Pine Street, N. Y. City.

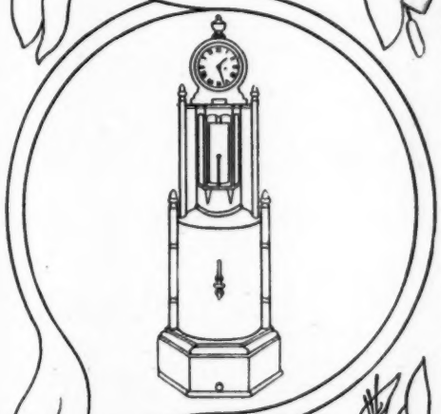
BOOKS.

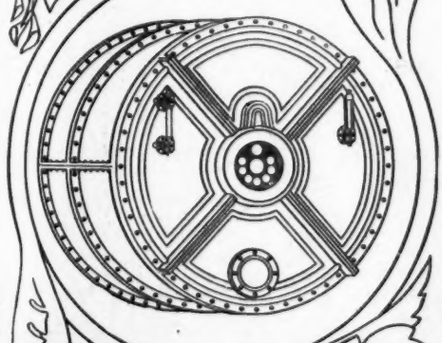
DISTILLATION OF COAL TAR AN AMMONIACAL LIQUOR.
By GEORGE LUNGE. Price $12.50.

TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS.
By DAVID A. GRAHAM. 8vo., Cloth. Price $3.
Orders for these books may be sent to this office.
A. M. CALLENDER & CO.,
PINE ST., N. Y. CITY









(Copyrighted, 1894, by the AMERICAN METER CO.

AMERICAN METER CO.

ESTABLISHED 1834. INCORPORATED 1863.

NEW YORK AND PHILADELPHIA,

CHICAGO, ST. LOUIS,

SAN FRANCISCO.

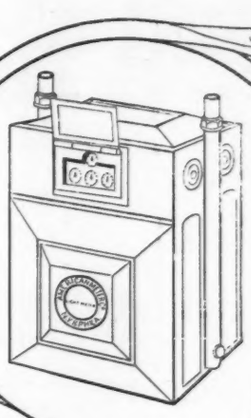
PUBLIC LIGHTING TABLE.

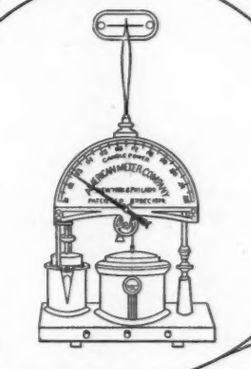
FEBRUARY, 1898.

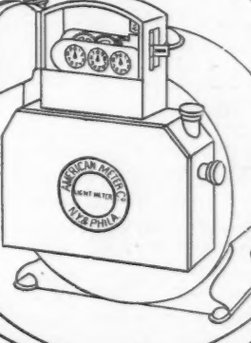
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Tue.	1	3.20 AM	6.10 AM	5.05	6.15
Wed.	2	4.10	6.10	5.05	6.15
Thu.	3	4.50	6.10	5.05	6.15
Fri.	4	5.20	6.10	5.05	6.15
Sat.	5	No L.	No L.	5.10	6 10
Sun.	6	No L. FM	No L.	5.10	6.10
Mon.	7	No L.	No L.	5.10	6.10
Tue.	8	6.00 PM	8.40 PM	5.10	6.10
Wed.	9	6.00	9.50	5.10	6.10
Thu.	10	6.00	11.00	5.10	6.10
Fri.	11	6.00	12.10 AM	5.10	6.10
Sat.	12	6.00	1.20	5.20	5.55
Sun.	13	6.10 LQ	2.30	5.20	5.55
Mon.	14	6.10	3.40	5.20	5.55
Tue.	15	6.10	4.40	5.20	5.55
Wed.	16	6.10	5.40	5.20	5.55
Thu.	17	6.10	5.50	5.20	5.55
Fri.	18	6.10	5.50	5.20	5.55
Sat.	19	6.10	5.50	5.30	5.55
Sun.	20	6.20 NM	5.40	5.30	5.55
Mon.	21	6.20	5.40	5.30	5.55
Tue.	22	6.20	5.40	5.30	5.55
Wed.	23	6.20	5.40	5.30	5.55
Thu.	24	6.20	5.40	5.30	5.55
Fri.	25	10.20	5.40	5.30	5.55
Sat.	26	11.20	5.40	5.30	5.45
Sun.	27	12.20 AM FQ	5.30	5.30	5.45
Mon.	28	1.10	5.30	5.30	5.45

TOTAL HOURS LIGHTING DURING 1898.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	210.40	January	423.20
February	186.40	February	355.25
March	181.20	March	355.35
April	166.10	April	298.50
May	156.40	May	264.50
June	144.30	June	234.25
July	147.30	July	243.45
August	157.10	August	280.25
September	169.50	September	321.15
October	186.00	October	374.30
November	204.30	November	401.40
December	218.30	December	433.45
Total, yr.	2129.30	Total, yr.	3987.45







$500.00 Reward!

THE PUBLIC IS CAUTIONED that imitation and worthless incandescent burners and mantles are being sold by unscrupulous dealers on the representation that they are the genuine "Welsbach."

THE WELSBACH LIGHT COMPANY will pay $500.00 reward for the arrest and conviction of any person representing and selling incandescent burners or mantles as genuine "Welsbachs" that do not bear our trade-mark.

All genuine Welsbach lights have stamped on the brass work "Welsbach System, Patented," and all genuine Welsbach mantles are branded with our trade-mark, "J," and both burners and mantles are sold in boxes bearing our trade name, "Welsbach."

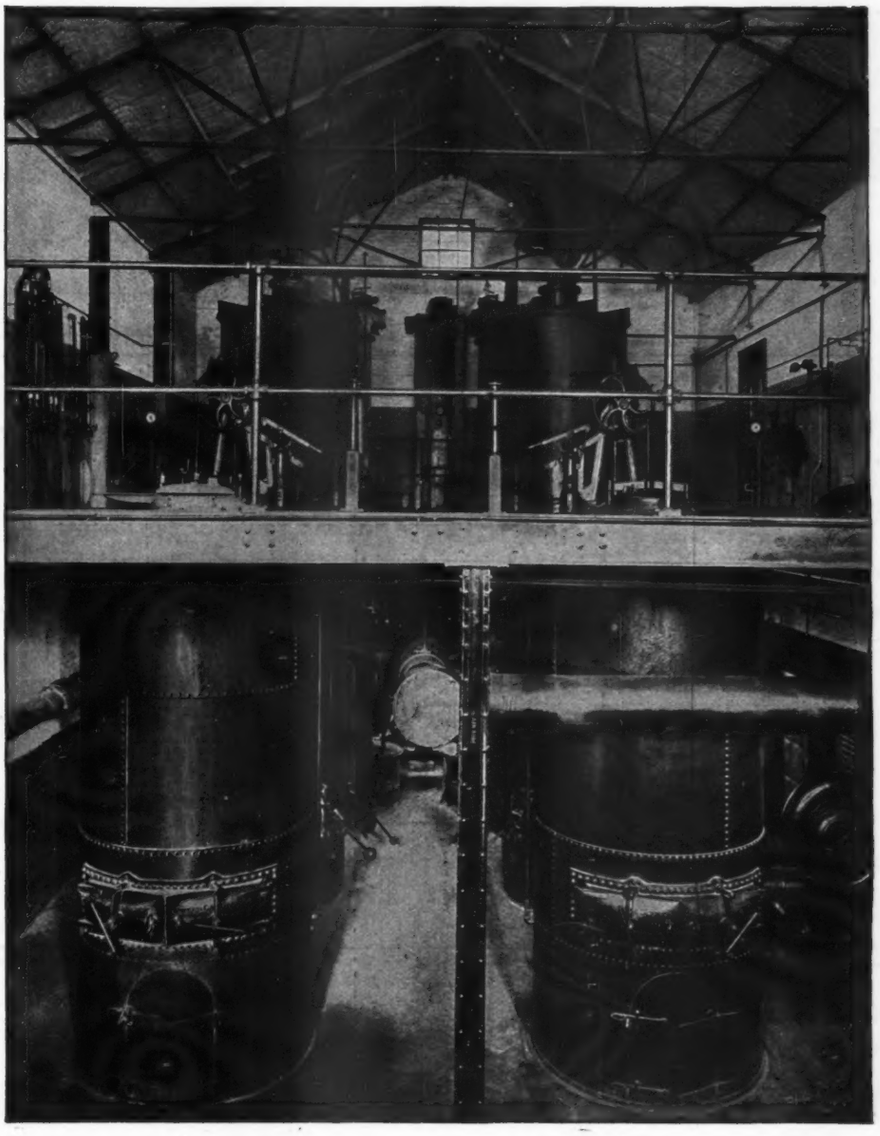
All other incandescent gas lamps and mantles are infringements of this Company's patents, notwithstanding representations to the contrary, and all manufacturers, sellers or USERS of infringing burners or mantles are liable to be and will be prosecuted.

WELSBACH LIGHT COMPANY.

Standard Double-Superheater Lowe Water Gas Apparatus.

Number of Installations to Date, - - 240

Total Daily Capacity, 128,200,000 Cu. Ft.



The United Gas Improvement Company,

DREXEL BUILDING, PHILA., PA.

ALEX. C. HUMPHREYS, M, E.,
BANK OF COMMERCE BUILDING,
(31 NASSAU STREET)
NEW YORK.

CABLE ADDRESS,
LONDON & NEW YORK,
"HUMGLAS."

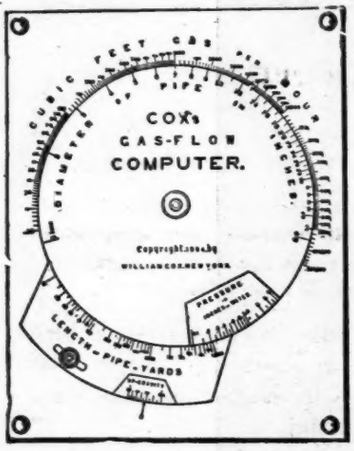
ARTHUR G. GLASGOW, M.E.,
9 VICTORIA ST.,
LONDON, S. W.,
ENGLAND.

HUMPHREYS & GLASGOW,

CONTRACTING AND CONSULTING

GAS ENGINEERS.

WATER GAS PLANT A SPECIALTY.
GAS PROPERTIES EXAMINED AND VALUED.
ADVICE AS TO IMPROVEMENT OF GAS PROPERTIES AND MANAGEMENT.



Do you wish to Know

what size of Pipe to use to convey any quantity of Gas, any distance, with any loss of pressure, and any initial or final pressure? Then use

COX'S GAS FLOW COMPUTER,

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

Price, 12 x 14 inches, on wooden board, $5.00.

For sale by

A. M. CALLENDER & CO., 32 Pine St., N. Y. City.

Coal Tar Genealogical Tree

MR. T. VINER CLARKE, of London, Eng.,

Having compiled a novel Chart or Map illustrating the various

CHEMICAL PRODUCTS DERIVED FROM COAL AND COAL TAR,

in the form of a Genealogical Tree, including all the products discovered to date (the total number amounting to near 700), offers for sale a limited number of copies in Colors, mounted on Linen, with Rollers. Price, $3.50. Orders may be sent to

A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.

THE MANAGEMENT OF SMALL GAS WORKS.

By C. J. R. HUMPHREYS.

Price $1.

A. M. CALLENDER & CO., No. 32 Pine Street New York.

NATIONAL GAS AND WATER CO.,

218 La Salle Street, Chicago.

Builder and Operator of Gas Works.

The Rew Soft Coal Carbureted Water Gas Apparatus.

TESTED BY THREE YEARS' PRACTICAL OPERATION, AND FULLY GUARANTEED.

Plans and Estimates Upon Application.

IRWIN REW, President and Treasurer. E. E. MORRELL, Engineer.

CONNELLY IRON SPONGE AND GOVERNOR CO.,

(Successors to CONNELLY & CO.)

MANUFACTURERS OF GAS WORKS SPECIALTIES.

"IRON SPONGE." Saves money, saves labor, and is the most efficient purifying material ever offered as a substitute for lime. We guarantee a large saving, both in cost of material and labor.

AUTOMATIC GOVERNOR. OVER FOUR HUNDRED NOW IN USE! NO WORKS COMPLETE WITHOUT IT! WILL PAY FOR ITSELF WITHIN A YEAR! ITS SERVICE SECURES PERFECT DISTRIBUTION! REDUCES LEAKAGE TO MINIMUM, and BENEFITS THE COMPANY and CONSUMER ALIKE! IT IS THE ONLY RECOGNIZED AUTOMATIC GOVERNOR IN THE WORLD!

STEAM JET EXHAUSTER. Designed particularly for small works. Combines Exhaust Tube, Steam Governor, Gas Compensator and Bye-Pass Valves in the most compact form possible. Occupies but little space; uses very little steam; saves formation of carbon in retorts; increases yield 10 to 15 per cent. No works too small to use them profitably.

Prices given on all our specialties, delivered at any point in the United States. Correspondence solicited.

CONNELLY IRON SPONGE AND GOVERNOR CO., No. 357 Canal St., New York.

Hughes' "Gas Works,"

Their Construction and Arrangement,

And the Manufacture and Distribution of Coal Gas.

Originally written by SAM'L HUGHES, C.E.

Rewritten and Much Enlarged by WM. RICHARDS, C.E.

Eighth Edition, Revised, with Notices of Recent Improvements.

Price, $1.65.

A. M. CALLENDER & CO., 32 Pine St., N. Y. City.

DOUGLAS' FERRIC OXIDE

For Gas Purification

Is a superior natural Hydrated Oxide of Iron. Will give a higher purification per bushel than any other material. We ship the pure Oxide of Iron, containing no sawdust, thus effecting a saving in freight, leaving the consumer to furnish the diluent at a nominal cost. It is now used by the largest gas companies in the West.

Full information, with references to many users, and prices delivered in any locality, furnished on application to

H.W. Douglas (Supt. Ann Arbor Gas Company) **Ann Arbor, Mich.**

ONEILL'S OXIDE,

(NATURAL BOG ORE)

For Gas Purification.

Has the Largest Annual Sale of Any Oxide in the World.

GAS PURIFICATION AND CHEMICAL CO., LTD.,

160, 161, 162 Palmerston Buildings,

Old Broad St., London, E.C., Eng.

Parson's Steam Blower,

FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.

PARSON'S TAR BURNER,

FOR UTILIZING COAL TAR AS FUEL.

PARSON'S AIR JET TUBE CLEANER,

FOR CLEANING BOILER TUBES.

These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY

H. E. PARSON, Supt., 67 Bremen Street, Brooklyn, N. Y.

JAMES D. PERKINS. **PERKINS & CO.,** F. SEAVERNS.

228 and 229 Produce Exchange, New York City.

TIDEWATER SALES AGENTS FOR THE FOLLOWING:

Ocean Mine Youghiogheny Gas Coal,

Clinch Valley, Thacker & Logan Gas Coals

Old Kentucky Shale and O. K. Boghead.

Shipments from New York, Philadelphia, Baltimore and Norfolk.

BERWIND-WHITE COAL MINING COMPANY'S

Ocean Westmoreland Gas Coal.

Offices:

Washington Building, New York.

Betz Building, Philadelphia.

STRICTLY High Grade. . . . .
Carefully prepared.
For Gas Making or
Heavy Steaming.

SCIENTIFIC BOOKS.

GAS MANUFACTURE, by William Richards. 4to., with numerous Engravings and Plates, in Cloth binding. $12.

TECHNICAL GAS ANALYSIS. $3.

GAS CONSUMER'S HANDYBOOK, by Wm. Richards, C.E. 20 cents.

CHEMISTRY OF ILLUMINATING GAS. By Norton H. Humphrys. $2.40.

PRACTICAL TREATISE ON HEAT By Thomas Box. 2d edition. $5.

RACTICAL PHOTOMETRY: A Guide to the Study of the Measurement of Light. By W. J. Dibdin. $3.

CHEMICAL TECHNOLOGY: Vol. I., *Fuel and Its Applications*, $5. Vol. II., *Lighting*, $4.

RONWORK: Practical Designing of Structural Ironwork. By H. Adams. $3.50.

GAS WORKS: Their Arrangement, Construction, Plant and Machinery. $5.

PRACTICAL HANDBOOK ON GAS ENGINES, by G. Lieckfield. $1.

LIQUID FUEL FOR MECHANICAL AND INDUSTRIAL PURPOSES. By E. A. Brayley Hodgetts. $2.50.

COAL, SPONTANEOUS COMBUSTION OF. By Thomas Rowan, C.E. $2.

COAL: Its History and Use. By Prof. Thorpe. $3.50.

THE GAS WORKS OF LONDON. By Colburn. 60 cents.

HEAT A MODE OF MOTION. By John Tyndall. $..

THE MANAGEMENT OF SMALL GAS WORKS. By C. J. R. Humphreys. $1.

MANUAL FOR GAS ENGINEERING STUDENTS. By D. Lee. 40 cents.

THEORY OF HEAT. By J. Clerk-Maxwell. $1.50.

GASFITTER'S GUIDE, by John Eldridge 40 cents.

AMMONIA AND AMMONIUM COMPOUNDS. By Dr. R. Arnold. $2

CONSTRUCTION OF GAS WORKS, by Walter Ralph Herring. $2.

DIGEST OF GAS CASES. $5.

PRACTICAL HINTS ON REGENERATOR FURNACES By M. Graham. $1.25.

DISTILLATION OF COAL TAR AND AMMONIACAL LIQUOR. By Geo. Lunge. New edition. $12.50.

A TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS. By D. A. Graham. $3.

A TEXT BOOK OF INORGANIC CHEMISTRY. By Prof. Victor Von Richter. $2.

ILLUMINATING AND HEATING GAS. By W. Burns. $1.50

HANDBOOK FOR MECHANICAL ENGINEERS. By H. Adams. $2.50.

TREATISE ON MASONRY CONSTRUCTION. Baker. $5

GAS ENGINEER'S LABORATORY HANDBOOK. By Jno. Hornby, F.I.C. $2.50.

GAS LIGHTING AND GAS FITTING. By W. P. Gerhard. 50 cents.

PRACTICAL PLUMBING. By P. J. Davies. $3.

GAS MANUFACTURE, THE CHEMISTRY OF, by W. J. A. Butterfield. $3.50.

AMERICAN PLUMBING. By Alfred Revill. $2.

CEMENT; A Manual of Lime and Cement, their Treatm and Use in Construction. By A. H. Heath. $2.50.

ELECTRICITY.

INDUSTRIAL PHOTOMETRY, with Special Application to Electric Lighting. By A. Palaz, Sc.D. $4.

ELEMENTS OF ELECTRIC LIGHTING, Including Electric Generation, Measurement, Storage and Distribution. By Philip Atkinson. $1.50.

ELECTRIC TRANSMISSION OF ENERGY. By G. Knapp. $3.50.

ELECTRICIAN'S POCKETBOOK. By Monroe and Jamieson. $2.50.

MAGNETISM AND ELECTRICITY. By J. Overend. 40 cts.

DYNAMO BUILDING. By F. W. Walker. 50 cents.

DOMESTIC ELECTRICITY FOR AMATEURS. By E. Hospitalier. $2.50.

PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. $1.

PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES. $1.

ELECTRIC LIGHTING, by Francis B. Crocker, E.M. $3.

ELECTRIC LIGHT FITTING. $2.

PRACTICAL ELECTRICITY. $2.50.

ELECTRICITY FOR ENGINEERS. $2.50.

ELECTRICITY, Its Theory, Sources and Applications. By John T. Sprague, M.I.E.E. $6.

The above will be forwarded upon receipt of price. If sent by mail or express, postage or express charges must be added to above prices. We take especial pains in securing and forwarding any other Works that may be desired, upon receipt of order. All remittances should be made by check, draft, or post office money order No books sent C.O.D.

A. M. CALLENDER & CO., 32 Pine Street, New York.

The Despard Gas Coal Co.,

MINERS AND SHIPPERS OF

DESPARD GAS COAL,

AND MANUFACTURERS OF

COKE.

MINES, - - Clarksburgh, Harrison Co., West Va.
WHARVES, - - - Locust Point, Baltimore, Md.
OFFICE, - 640 Equitable Building, Baltimore, Md.

ROUSSEL & HICKS, 71 Broadway, N. Y. } AGENTS, { BANGS & HORTON 60 Congress St., Boston.

W. D. ALTHOUSE & CO.

Reading Terminal—Philadelphia.

"Shaner," Westmoreland, Pa.

HIGH GRADE GAS COAL
AND
KENTUCKY CANNELS.

REPRESENTED BY

THOS. N. MORDUE, No. 1 Broadway, N Y

KELLER ADJUSTABLE COKE CRUSHER.

Strong, Simple, Durable. Will Crush any Size Desired.

C. M. KELLER,
Sec. & Supt. Gas Lt. & Coke Co.,
Columbus, Ind.
Correspondence Solicited.

GREENOUGH'S "DIGEST OF GAS CASES."

Price, $5.00.

This is a valuable and important work, a copy of which should be in the possession of every gas company in the country, whether large or small. As a book of reference it will be found invaluable. It is the only work of the kind which has ever been published in this country, and is most complete. Handsomely bound. Orders may be sent to

A. M. CALLENDER & CO., 32 Pine St., N. Y.

— THE —

PENN GAS COAL CO.

OFFER THEIR

Coal, Carefully Screened and Prepared for Gas Purposes.

Their property is located in the Youghiogheny Coal Basin, near Irwin and Penn Stations on the Pennsylvania Railroad, and on the Youghiogheny River.

Principal Office:

Room 720, Reading Terminal Building, Phila., Pa.

Points of Shipment:

Pennsylvania Railroad Piers; Greenwich Wharves, Delaware River; Pier No. 1 (Lower Side), South Amboy, N. J.

EDMUND H. McCULLOUGH, Prest. CHAS. F. GODSHALL, Treas. H. C. ADAMS, Sec.

THE WESTMORELAND COAL CO.

Chartered 1854.

Mines situated on the Pennsylvania and the Baltimore and Ohio Railroads, in Westmoreland County, Pa.

POINTS OF SHIPMENT:

PHILADELPHIA, BALTIMORE, SOUTH AMBOY, N. J.,
WATKINS (SENECA LAKE), N. Y.

Since the commencement of operations by this Company its well-known Coal has been largely used by the Gas Companies of New England and the Middle States, and its character is established as having no superior in gas-giving qualities, and in freedom from sulphur and other impurities.

Principal Office, 224 South 3d St., Phila., Pa.

THE SUN OIL CO.,

Crude Oil, Gas Naphtha,
Refined Petroleum, Gas Oil.

Toledo, O., and Pittsburgh, Pa.

Standard Oil Company,

GAS NAPTHA DEPARTMENT.

GAS NAPTHA.

GAS OIL.

Correspondence Solicited.

26 Broadway, New York City,

Established 1858. Incorporated 1890.
CHAS. E. GREGORY Prest. DAVID R. DALY V. Prest. & Treas.
H. D. ABERNETHY. Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
Jersey City, N. J.

MANUFACTURERS OF

CLAY GAS RETORTS, FIRE CLAY TILES,
FIRE BRICK and FIRE CLAY SPECIALTIES

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE

FLEMMING GENERATOR GAS FURNACE

Brooklyn Fire Brick Works,

MANUFACTURERS OF

CLAY RETORTS, FIRE BRICK,
Gas House and other Tile.

Office, 88 Van Dyke St., Brooklyn, N. Y.

Established 1854. Incorporated 1869.

LACLEDE
Fire Brick Manufg. Co.,

Manufacturers of { GAS RETORTS . .
FIRE BRICK . . .
RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Exclusive Agents for

The Mitchell Half-Depth Regenerative Furnace.

This is the *original* coal-consuming Furnace for Retort Benches. Burns either Coal or Coke. Full and Half-Depth Regenerative Furnaces for Benches of 6's, 7's, 8's or 9's erected complete.

Proprietors of the Coze System of Inclined Retorts.

Office: 901 Pine St., **St. Louis, Mo.**

ESTABLISHED IN 1845.

B. KREISCHER & SONS,

Office, 119 E. 23d St., New York.

Gas Retorts,

TILES, FIRE BRICK.

AND EVERYTHING IN THE FIRE CLAY LINE.

Adam Weber,

Proprietor,

Manhattan Fire Brick and Enameled Clay Retort Works.

Works, Weber, N. J.

Office, 633 East 15th St., New York.

Modern Recuperative Furnaces

And Standard Fire Brick and Gas Retorts.

Works,
LOCKPORT STATION, PA.

—ESTABLISHED 1864.—

JAMES GARDNER, JR.,

Hamilton Building, Fifth Avenue,
PITTSBURGH, PA. P. O. Box 373

Successor to WILLIAM GARDNER & SON

Fire Clay Goods for Gas Works.

SOLE REPRESENTATIVE OF THE McILHENNY REGENERATIVE BENCHES FOR THE U. S.

HENRY MAURER & SON.

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY

RETORT WORKS

WORKS, Perth Amboy, N. J.
OFFICE, 418 to 422 East 23d St., N. Y

Clay Gas Retorts,

BENCH SETTINGS,

Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT.

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

PRICE LIST.

In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

C. L. GEROULD & CO.,

N. 3d & Prospect Avs., Mt. Vernon, N.Y.

Western Agent, H. T. GEROULD, Centralia, Ills.

Parker-Russell Mining and Mfg. Co.,

CITY OFFICE,
417 Pine Street, St. Louis, Mo.

PROPRIETORS OF THE

OAKHILL GAS RETORT & FIRE BRICK W'KS

Our immense establishment is now employed almost entirely in the manufacture of

Materials for Gas Companies

We have studied and perfected three important points. Our retorts are made to stand changes of temperature, the strongest heats of the furnace, and the abrasion of feeding and emptying. We construct

Half and Full Depth Benches of Our Own Design,

Containing 6, 8 or 9 Retorts.

We have Greatly Improved our Recuperators. Coal or Coke can be used as Fuel in Furnaces.

THEO. J. SMITH, Prest. J. A. TAYLOR, Sec'y
A. LAMBLA, Vice-Prest. and Supt.

BALTIMORE

RETORT & FIRE BRICK CO.

MANUFACTORY AT

LOCUST POINT BALTIMORE MD.

Clay Retorts, Blocks & Tiles

FIRE BRICK, FIRE CLAY,
AND FIRE CEMENT.

Red and Buff Ornamental Tiles and Chimney Tops. Baker Oven Tiles 12x12x2 and 16x16x2.

WALDO BROS., 102 MILK ST., BOSTON, MASS.

Sole Agents for New England States.

PRACTICAL PHOTOMETRY.

A Guide to the Study of the Measurement of Light.

By WILLIAM JOSEPH DIBDIN.

With Numerous Illustrations. Price, $3.00. A. M. CALLENDER & CO., 32 Pine Street, N. Y. City

WM. W. GOODWIN, Prest. O. N. CULDLIN, V.-Prest. & Treas. H. B. GOODWIN, Sec. ERNEST F. LLOYD, Asst. Sec

THE AMERICAN GAS ENGINE CO.,

MANUFACTURERS OF

The Double-Acting Gas Engine,

Under the Patents of Griffin, and Dick, Kerr & Co., of London and Kilmarnock.

Single Cylinder.

Impulse Every Revolution.

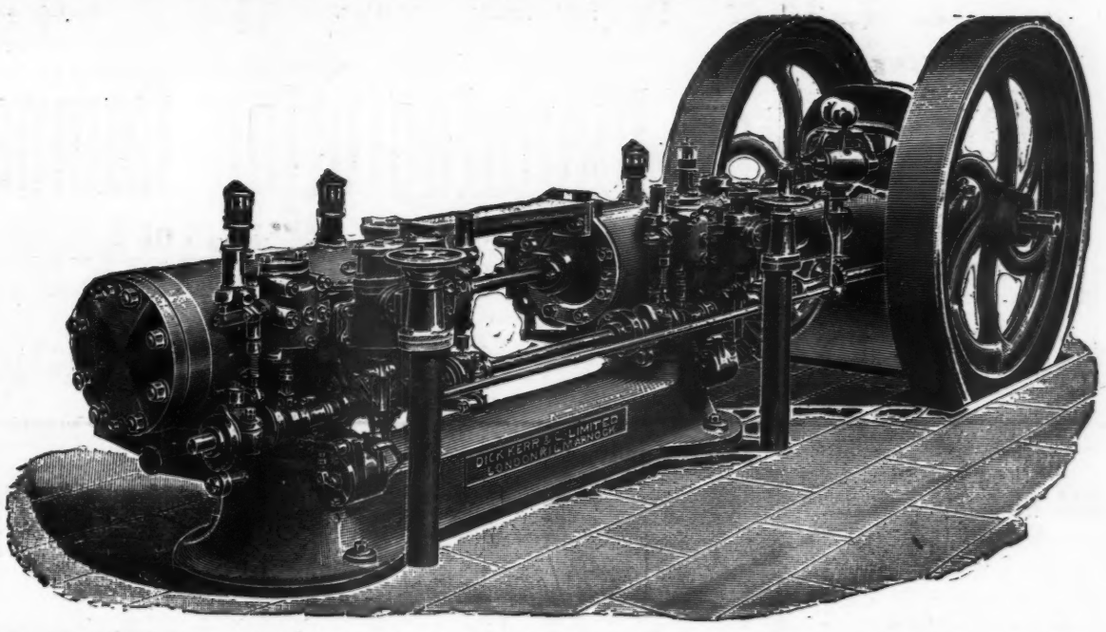
(Two Strokes.)

15 to 500 Horse Power

For General Work and Isolated Electric Plants.

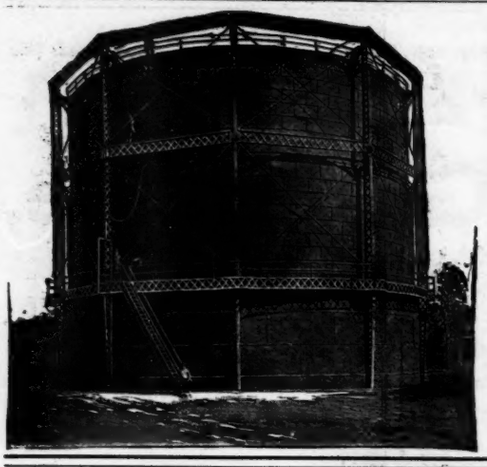
Tandem Cylinder. Impulse Every Stroke 100 to 1,000 Horse Power.

For Central Stations and all work requiring extreme steadiness.



ESSENTIAL PRINCIPLE.—An impulse at each end of piston; using half force to each impulse; doubling the steadiness; reducing the wear on moving parts, and weight for given power. **CONSTRUCTION.**—The piston rod works through stuffing box in front end of cylinder, and connecting rod is carried in a cross-head working in a slide in frame, as in ordinary steam engine practice. All valves are of the poppet type, operated by cams on a single cam-shaft, giving positive movement to every working part. Tube or electric ignition. **RESULT.**—An engine of extreme simplicity and steadiness of action, the even wear on the cylinder and all working parts assuring increased economy, long life, and minimum cost in repairs. **RECORD.**—Successful and constant use in Great Britain for the past eight years. Address

W. W. GOODWIN, President, 532 Bourse Building, Philadelphia Pa. or
THE WESTERN GAS CONSTRUCTION CO. Bldrs. & Gen. Agts. Fort Wayne Ind.



DAVIS & FARNUM MFG. CO.,

WALTHAM, MASS.

Principal Office & Works, Waltham, Mass. Boston Office, R'm 18, Vulcan Bldg., 8 Oliver St.

Single, Double and Triple-Lift Gasholders of any Capacity. Tubular, Pipe and Sinuous Friction Condensers of all Sizes.

Steel Tanks for Gasholders, Iron Roof Frames and Floors, Purifying Boxes, Center Seal or Valve Connections, Bench Work, Reversible Lime Trays.

Self-Sealing and Pressed Steel Mouthpiece Lids.

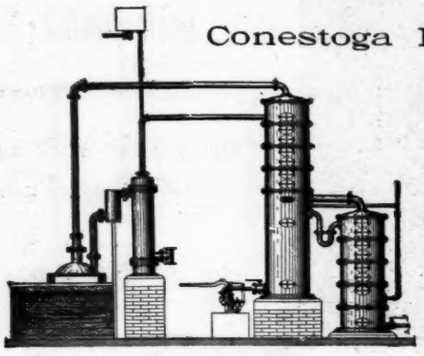
Coke Borrows, Coal Wagons, and all Apparatus Requisite for a Complete Gas Works.

Also, Gas and Water Pipe, Flanged Pipe, Sugar House Work, and Special Castings of all Descriptions.

GAS ENGINEERING COMPANY.

INCORPORATED,

Conestoga Building, PITTSBURGH, PA.



AMMONIA MACHINE.

MANUFACTURERS OF

Gas Works Machinery of all kinds,

PATENTEES AND OWNERS OF

PITTSBURGH WASHER-SCRUBBER,

SOLE AGENTS FOR

FELDMANN AMMONIA MACHINE,

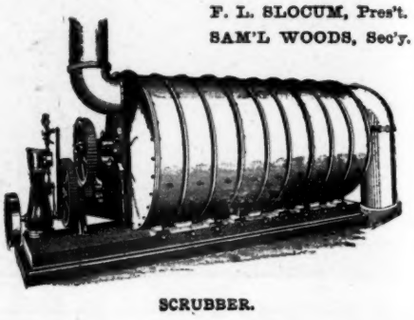
For producing Sulphate, Aqua, Chloride and Concentrated Liquors.

The Erection of Bi-Product Coke Ovens a Specialty.

Faux System of Recuperative Benches.

NEW SYSTEM HYDRAULICS.

F. L. SLOCUM, Pres't.
SAM'L WOODS, Sec'y.



SCRUBBER.

Kerr Murray Manufacturing Company,

Steel Gasholder Tanks,

SINGLE, DOUBLE AND TRIPLE-LIFT GASHOLDERS,

HORIZONTAL AND VERTICAL STORAGE OIL TANKS

Iron Work for Coal Gas Benches, Self-Sealing Mouthpieces, Exhausters, Condensers, Scrubbers, Purifiers, Wooden Trays, Floor Carriages, Center Seal and Valve System Connections, Cast and Wrought Iron Fittings, and Connections 3 to 36 Inches Diameter.

VALVES, Double Gate, Hub and Flange, Outside Screw and Quick Opening, 3 to 36 In. Diam.

COAL AND COKE WAGONS, RETORT HOUSE TOOLS, STREET MAIN SPECIALS AND DRIPS.

Address,

KERR MURRAY MANUFACTURING CO.

Fort Wayne, Indiana.

BARTLETT, HAYWARD & CO.

BALTIMORE, MD.

Triple, Double & Single-Lift

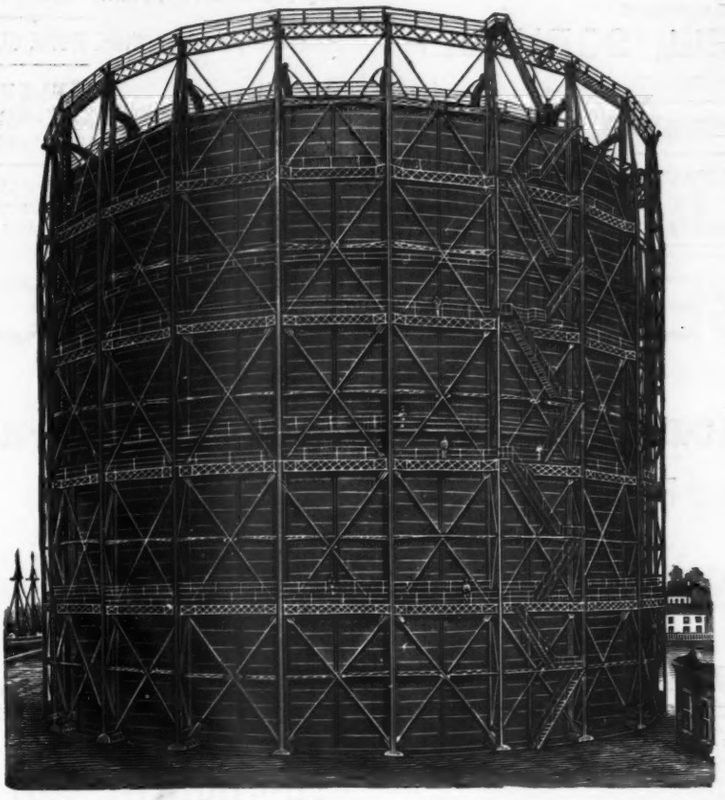
GASHOLDERS.

Iron Holder Tanks.

ROOF FRAMES.

Girders.

BEAMS



PURIFIERS.

CONDENSERS.

Scrubbers.

Bench Castings.

OIL STORAGE TANKS

Boilers.

Three Four-Lift Gasholders, each of 4,289,500 Cubic Feet Capacity, Erected in Chicago.

The Wilkinson Water Gas Process.

THIRTY-CANDLE, NON-CONDENSABLE, FIXED GAS. THE MOST SUCCESSFUL GAS PROCESS IN OPERATION.

MILL'S REVERSIBLE LIME TRAYS.

Gas Works Designed and Constructed.

PRACTICAL HANDBOOK ON

GAS ENGINES

With Instructions for Care and Working of the Same.

By G. LIECKFELD, C.E.

Translated with Permission of the author by GEO. M. RICHMOND, M.E.

Price, $1.00.

A. M. CALLENDER & CO., 32 Pine Street, New York.

Foundries and Works: { Millville, N. J. Florence, " Camden, "

R. D. WOOD & CO.

ENGINEERS, IRON FOUNDERS, MACHINISTS

400 Chestnut Street, PHILADELPHIA, PA.

MANUFACTURERS OF

CAST IRON PIPE

SOLE MAKERS OF

THE MITCHELL SCRUBBER

(PATENTED)

PURIFIERS, CONDENSERS, SCRUBBERS.

THE HOPPER AUTOMATIC GAS GOVERNOR.
BENCH WORK. PLATE GIRDERS.
IRON FLOORS AND ROOFS.

BUILDERS OF

GAS HOLDERS

Single, Double and Triple Lifts, with or without Wrought Iron or Steel Tanks

PEASE'S PATENT WIRE ROPE GUIDING FOR GAS HOLDERS

CUTLER'S
PATENT FREEZING PREVENTER
FOR GAS HOLDER CUPS.

THE TAYLOR REVOLVING BOTTOM GAS PRODUCER,
HEAVY LOAM CASTINGS, DUNHAM SPECIALS, HYDRAULIC WORK
LAMP POSTS, VALVES, ETC.

ISBELL-PORTER CO.,

ENGINEERS AND CONTRACTORS FOR THE

Construction and Extension of Gas Works.

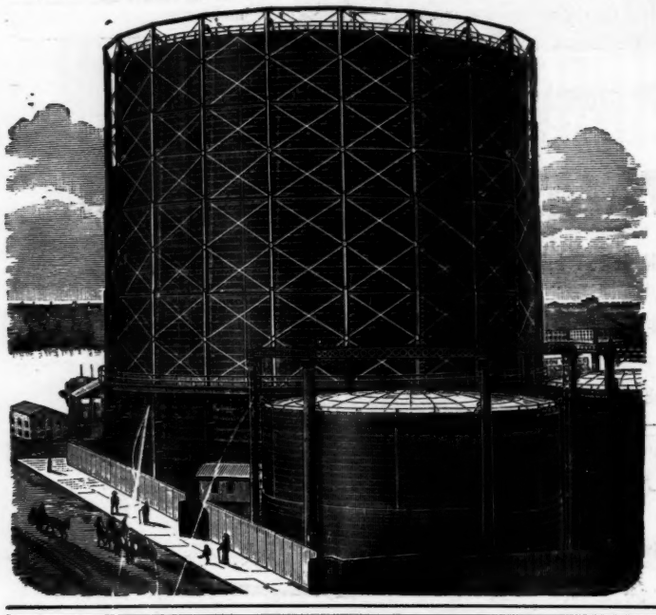
FOUNDERS AND MACHINISTS.

MANUFACTURERS OF

All Ironwork and Machinery Required in a Gas Plant.

Estimates, Drawings and Specifications furnished for the Alteration, Improvement, or Extension of Existing Works or the Construction of New Works.

245 Broadway, New York City. OFFICES Bridge & Ogden Sts., Newark, N. J.



The Continental Iron Works,

THOMAS F. ROWLAND, President.
WARREN E. HILL and CHAS. H. CORBETT, Vice-Presidents.
THOMAS F. ROWLAND, Jr., Secretary & Treasurer.

BROOKLYN, N. Y.

TAKE EAST TENTH OR TWENTY-THIRD STREET FERRIES FROM N. Y. TO GREENPOINT.

BUILDERS OF

Gas Holders.

Single and Multiple Section Gas Holders a Specialty.

Wrought Iron Gas Holder Tanks

BENCH CASTINGS, RETORT LIDS.

Hydraulic Mains, Condensers, Scrubbers
Purifiers, Valves, Etc.

Self-Sealing Retort Mouthpieces & Lids

For Round, Oval, or "D" Retorts.

ILLUMINATING GAS! FUEL GAS!

THE LOOMIS PROCESS.

Now in successful operation at Works of John Russell Cutlery Co., Turner's Falls, Mass., and Henry Disston's Son's Saw Works, Tacony, Pa.

The Cheapest Gas Generating System in the World.

Plans and Estimates Furnished.

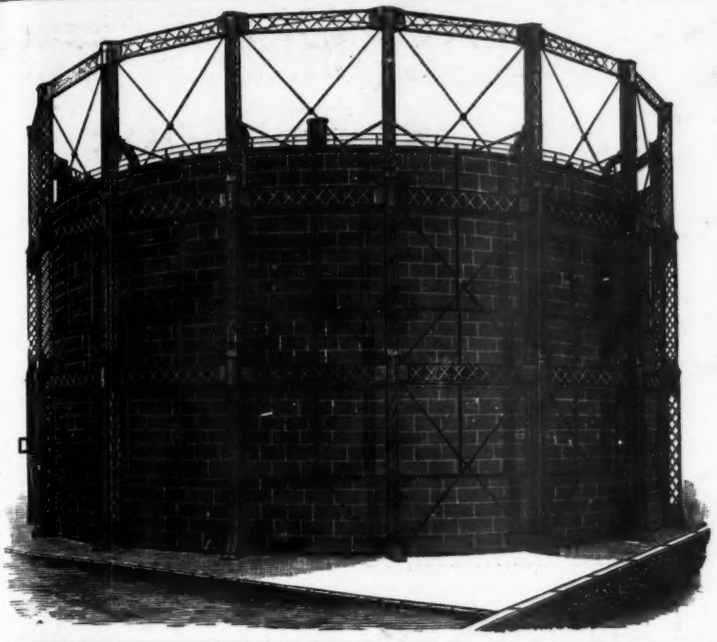
BURDETT LOOMIS, - - Hartford, Conn.

To Gas Companies.

We make to order CAP BURNERS to burn any amount under a stated pressure. Send for samples.

Also, SERVICE CLEANERS, DRIP PUMPS, and STREET MAIN PROVING APPARATUS.

C. A. GEFRORER,
948 N. 8th St., Phila., Pa.



H. RANSHAW, Prest. & Mangr. T. H. BIRCH, Asst. Mangr
WILLIAM STACEY, Vice-Prest. R. J. TARVIN, Sec. & Treas.

THE STACEY MANUFACTURING CO

Established 1851.

Single, Double and Triple-Lift

GASHOLDERS,

Of any Capacity, with or without Wrought Iron or Steel Tanks.

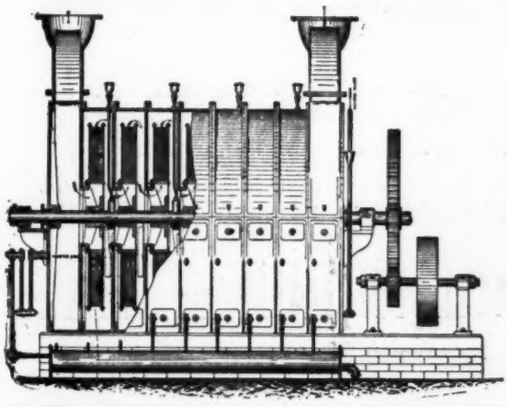
Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, etc.

Coal Gas Benches, Roof Frames,

OIL STORAGE TANKS.

Pressed Steel Mouthpiece Lids, Self-Sealing Mouthpiece Lids.

Cincinnati, Ohio.



GEORGE SHEPARD PAGE'S SONS,

AGENTS FOR

The Ammonia Washer-Scrubber

The Ammonia Scrubber (late "Standard") has been before the American Gas Engineers for the past nineteen years. During that time many improvements have been made by the builders, the Isbell-Porter Company, until to-day it stands at the head of all Scrubbers. The fact of there being nearly ninety in use, with a combined capacity of 70,000,000 cubic feet per 24 hours, is of itself sufficient indorsement of its merit. There is no other Scrubber built giving so little back pressure and so much area per thousand cubic feet. Do not be induced to put in a Scrubber until you have acquainted yourself with the AMMONIA SCRUBBER.

Write for Circulars and Blue Prints.

69 Wall Street, - - New York City.

GEORGE R. ROWLAND.

Formerly with the Continental Iron Works.

Draughtsman and Constructing Engineer.

Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.

Office, No. 245 Broadway, N. Y. City.

W. H. PEARSON, Prest. J. W. WESTCOTT, Gen'l Mangr. and Treas. L. L. MERRIFIELD, Chief Engr.

THE ECONOMICAL GAS APPARATUS CONSTRUCTION COMPANY, Limited

269 Front Street, East, Toronto, Canada.

ENGINEERS AND BUILDERS OF THE **IMPROVED LOWE WATER GAS APPARATUS.**

Designed to give the Greatest Efficiency when using any kind of Oil, Anthracite Coal, Gas House or Oven Coke.

New Gas Works Built, Present Gas Plants, either Coal or Water, Remodeled

Catalogues, Plans and Estimates Furnished upon Application.

WM. HENRY WHITE,

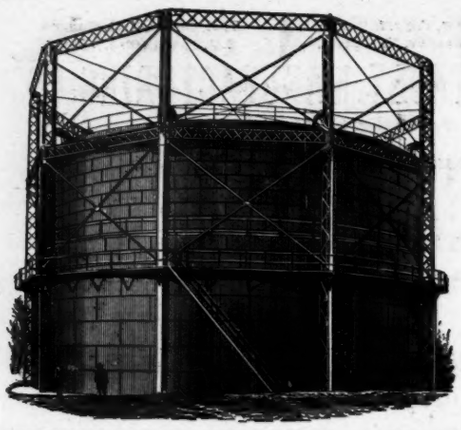
No. 32 Pine Street, - - - New York City.

ENGINEER AND CONTRACTOR FOR THE

ERECTION AND EXTENSION OF

GAS, WATER, AND ELECTRIC LIGHT WORKS.

Correspondence with Gas Companies contemplating extending or improving their Plants respectfully invited. Plans and Estimates Furnished.



1842 * Deily & Fowler, * 1898

LAUREL IRON WORKS.

Office, No. 39 Laurel Street, Philadelphia, Pa

BUILDERS OF

Gasholders

Single or Telescopic. With or Without Iron or Steel Tanks.

OIL TANKS, WATER TANKS, AND GENERAL WROUGHT IRON WORK.

JAMES R. FLOYD'S SONS,

Successors to HERRING & FLOYD,

Oregon Iron Works,

West 20th and 21st Streets, Between 10th & 11th Avenues, New York City.

Engineers and Contractors for the Construction of Gas Works.

MANUFACTURERS OF ALL KINDS OF CASTINGS AND GENERAL IRONWORK FOR GAS APPARATUS.

Bench Castings, Regenerative and Half Regenerative Furnace Castings, Condensers, Tower Scrubbers, Mechanical Scrubbers, Purifiers, Malleable Iron Retort Lids, Self-Sealing Retort Lids, Hydraulic Hoist Purifier Carriage, Crosses, Tees, Bends, Angles, Reducers, S-Bends, Sectional Sleeves, Plugs, Caps, Street Drips, etc., always on hand.

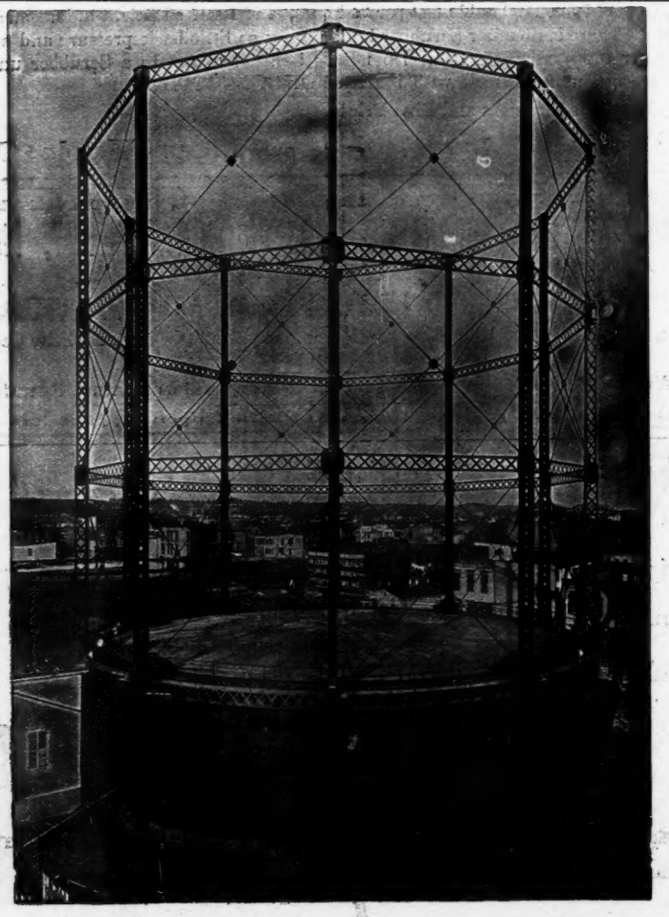
WOOD'S GAS SCRUBBING AND ENRICHING APPARATUS.

In use at Syracuse, Auburn, Watertown, Cortland and Geneva, N.Y.; Elizabeth, N. J.; Boston, Mass.; Jamaica Plain, Mass.; Providence, R. I.; Northern Liberties Gas Co., Phila.

Sole Manufacturers of the OGDEN QUICK-MOVING VALVE.

HEARNE CENTER SEAL, Operating One, Two, Three or Four Boxes.

Stroh & Osius Concentrator for Ammoniacal Liquor, used by 50 Gas Companies and Cokeries during the past 4 years.



The order for this Triple-Lift Holder and Steel Tank was received by the Logan Iron Works from the Union Gas Light Company, of East New York. The contract was completed and the Holder was in actual use in 90 days from receipt of order. Capacity of Holder, 500,000 Cu. Ft.

LOGAN IRON WORKS,

Brooklyn, N. Y.

MANUFACTURERS OF

Single or Multiple-Lift

GASHOLDERS,

Complete with Steel Tanks.

BENCHES, SCRUBBERS,

CONDENSERS,

PURIFIERS, IRON ROOFS,

Self-Sealing Retort Lids,

AND ALL PARTS OF

GAS WORKS APPARATUS

Contractors for Complete Works.

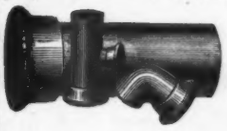
ALSO, SOLE MANUFACTURERS OF

C. W. BLODGET'S

HOT GAS SCRUBBER.

THE OHIO PIPE COMPANY,
MANUFACTURERS OF
Cast Iron Gas & Water Pipe,
BRANCH AND SPECIAL CASTINGS.
Gas-House Bench Castings, Hydraulics, Lamp Posts, Flange Pipe and Specials, Architectural Castings, Building Columns, Joists, Cellar Grates, Sash Weights, etc.
GENERAL FOUNDERS AND MACHINISTS
Columbus, Ohio.

DAVID LEAVITT HOUGH,
26 CORTLANDT ST., N.Y. CITY.
Consulting Engineer.
Investigations and Appraisals.
Designs and Estimates.
Contractor.
Machinery and Structures.
Gas and Water Pipe.
Special Agent for Selling & Purchasing.

WARREN FOUNDRY AND MACHINE CO.,
Established 1856. Works at Phillipsburgh, N. J.
New York Office, 160 Broadway.

CAST IRON WATER AND GAS PIPE,
FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF
Flange Pipe for Sugar House and Mine Work. Branches. Bends, Retorts, etc., etc

EASTERN OFFICE: NEW YORK, 152 BROADWAY. WESTERN OFFICE CHICAGO, MONADNOCK BLK
M. J. DRUMMOND
MANUFACTURER OF
CAST IRON
FLANGE
GAS AND WATER PIPE
AND GENERAL FOUNDRY WORK

GEORGE ORMROD, Mangr. & Treas., Emaus, Pa.
JOHN DONALDSON, Prest., Betz Bldg., Phila., Pa
EMAUS PIPE FOUNDRY.
DONALDSON IRON COMPANY. EMAUS, PA

MANUFACTURERS OF
CAST IRON PIPE AND SPECIAL CASTINGS
FOR WATER AND GAS.
Also, FLANGE PIPE, LAMP POSTS, Etc.

1894 DIRECTORY 1894
OF AMERICAN GAS COMPANIES
Price, - - - - - - - - - $5.00.
A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.

Established 1854.
D. McDONALD & CO.,
MANUFACTURERS OF
WET AND DRY METERS, STATION METERS AND METER PROVERS.
—ALSO MAKERS OF
THE GLOVER PREPAYMENT METER.

The amount of gas delivered for the coin can be instantly and positively changed without removing the meter or replacing any parts.

The gas registered agrees absolutely with the amount purchased by the coin.

WE HAVE MADE AND SOLD IN THE UNITED STATES
OVER 20,000 OF THESE METERS,
ALL OF WHICH ARE GIVING PERFECT SATISFACTION.
Correspondence Solicited.
511 West Twenty-first Street, NEW YORK. | 51, 53 & 55 Lancaster Street, ALBANY, N. Y. | 34 & 36 West Monroe Street, CHICAGO.

NATHANIEL TUFTS METER CO.,

63 Beverly Street, Boston, Mass.

MANUFACTURERS OF

DRY GAS METERS.

Station Meters of any Capacity.

Test and Experimental Meters, Pressure Registers, Pressure Gauges.

METER PROVERS, PHOTOMETERS, STREET LANTERNS, ETC., ETC.

Apparatus for the Chemical Testing of Gas and Gas Liquor.

Established 1849. With the best facilities for manufacturing, is enabled to furnish reliable work and answer orders promptly.

CHARLES E. DICKEY. JAMES B. SMALLWOOD. CHARLES H. DICKEY.

THE MARYLAND METER AND MANUFACTURING CO.

Established 1866.

BALTIMORE, North & Saratoga Sts. **CHICAGO, 107 West Monroe St.**
NEW YORK, 838 Broadway. **SAN FRANCISCO, 221 Front St.**
BOSTON, 92 Water Street, Rooms 21 and 22.

CONSUMERS' & STATION METERS, PRESSURE GAUGES, Etc., Etc.

"Perfect" Gas Stoves

METRIC METAL COMPANY,

MAKERS OF

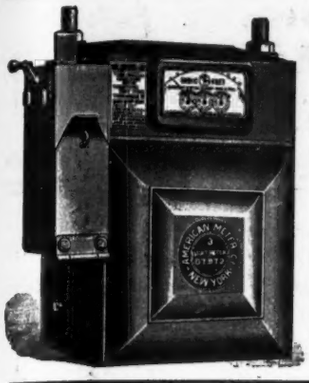
GAS METERS for NATURAL and ARTIFICIAL GAS.

Special Attention given to Repairing METERS of all Makes.

FACTORY AT ERIE, PA.

Use Keystone Meters.

Royersford, Pa.



American Meter Co.

NEW YORK, PHILADELPHIA,
SAN FRANCISCO.

Prepayment Meters.

Their construction is such that they may be readily readjusted when the scale of gas rates is changed.

HELME & McILHENNY,

Established 1848. **1339 to 1349 Cherry Street, Philadelphia, Pa.**

MANUFACTURERS OF

Wet and Dry Gas Meters, Station Meters, Provers, Gauges, Etc.

METERS REPAIRED

PREPAYMENT GAS METERS.

Our Own Patents. Strong. Simple. PROMPT ATTENTION. CORRESPONDENCE SOLICITED.

FIELD'S ANALYSIS

For the Year 1896.

An Analysis of the Accounts of the Principal Gas Undertakings in England, Scotland, and Ireland. Being the Twenty-eighth Year of Publication. Compiled and Arranged by

JOHN W. FIELD, Sec. & Gen. Mangr. of The Gas Lt. & Coke Co., London.

Price, $5. For Sale by

A. M. CALLENDER & CO., - No. 32 Pine Street, N. Y. City.

T. D. BUHL, President. CHAS. H. JACOBS, Secretary-Treasurer.

DETROIT METER COMPANY,

DETROIT, MICH.

Makers of Gas Meters.

OUR equipment embraces the Latest and Most Improved Machinery. We make our own Tin Plate. We claim for **"BUHL" METERS, Increased Durability,** with probability of **Fewer and Less Expensive Repairs,** and **More Accurate Adjustment.**

Comparisons Invited. Meters of other Makers Promptly Repaired.

MAIL ORDERS SOLICITED.

The advertisement of

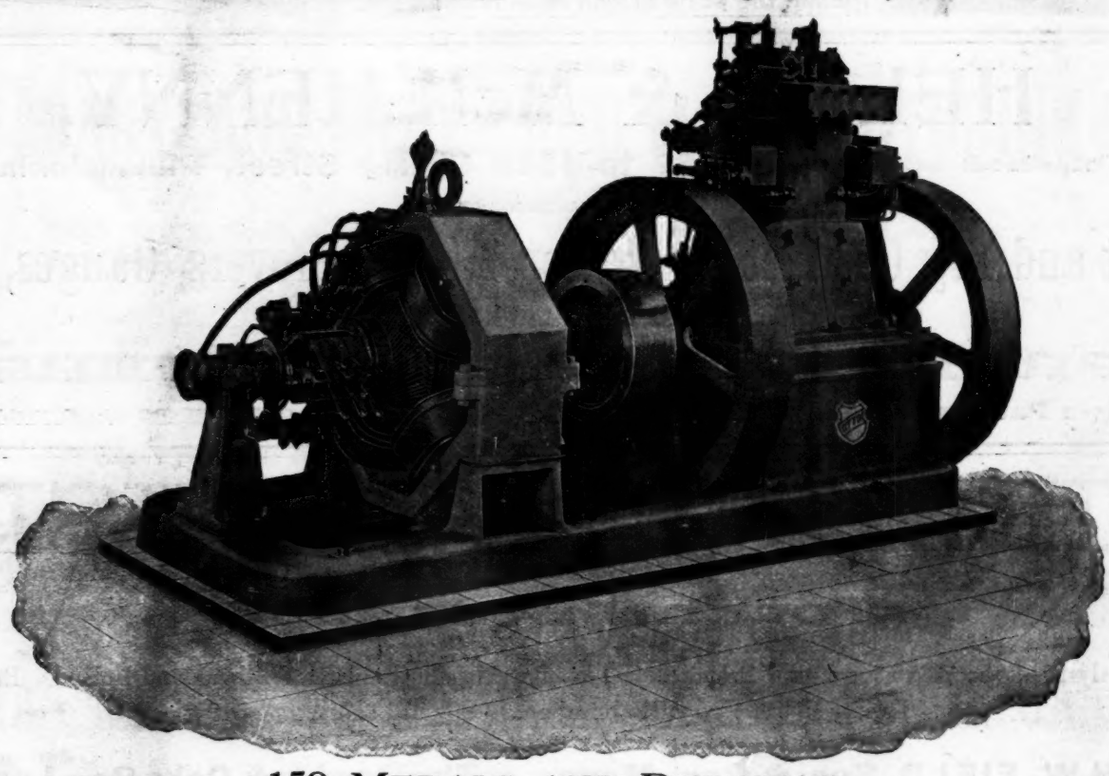
JOHN J. GRIFFIN & CO., Mfrs. of Gas Meters, etc.,

Nos. 1513, 1515, 1517, 1519 & 1521 Race Street, Philadelphia,
52 Dey Street, New York, 75 N. Clinton Street, Chicago,

Occupies this page every alternate week.

UNEQUALED

For efficiency and low gas consumption.
For smooth and quiet running.
For simplicity of construction and grace in design.
For general reliability.
For close regulation of power.



150 MEDALS AND DIPLOMAS.

Direct Coupled "OTTO" Gas Engine and Dynamo.

DEMONSTRATION

It is almost a quarter of a century since the "Otto" revolutionized old and bad practices by introducing principles of combustion "entirely new" in the construction of Gas Motors.

A quarter of a century of uninterrupted success has demonstrated the correctness of these principles.

The gas engine history of the past proves that all competitors have recognized this fact by becoming imitators.

Since its advent the "Otto" engine has been illustrating mechanical improvement without alteration, while others have been offering alterations as improvements.

The experience of the past shows that it requires years to determine the real merits of a gas engine, and that nearly all new gas engines prove failures. **The fittest survive, and the only safe thing to do** in selecting a gas engine is to buy what the tests of practical use, through a long period of time, have proven to be the best.

The Practical Tests of a Quarter of a Century have Demonstrated that the "OTTO" Stands To-day Unrivaled

For simplicity of construction and grace in design; for general reliability and ease of management; for quiet and smooth running qualities; for efficiency and low gas consumption; for regularity of speed and close regulation of power.

THE OTTO GAS ENGINE WORKS, Inc., 33d & Walnut Sts., Phila., Pa.

NEW YORK, 39 Courtland St. BOSTON, 19 Pearl St. CHICAGO, 245 Lake St.